THE FOUNDRY

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Making Car Wheels at Lenoir Car Works---III

Discussion of the Molding Practice—Rapid Handling of Hot Metal Required to Secure Best Results—Sand and Foundry Flour Specifications

By G S Evans

COMMON gray iron castings permit of comparatively wide variations both in chemical composition and in molding practice, without seriously impairing the quality of the castings, but chilled castings, and chilled wheels in particular, require exactness in composition, molding and annealing practice to produce wheels that will withstand the high speeds and heavy loads of today.

Among the many factors affecting the strength and properties of chilled wheels the following are probably the most important:

1—Composition of the molten iron.
2—Character and condition of the mold.
3—Temperature at which the wheel is poured.
4—Rate at which the wheel is poured.
5—Time that the wheel is allowed to remain in the mold.
6—Temperature at which the wheel is charged into the annealing pits.
7—Anneal to which the wheel is subjected.

The M. C. B. A. 1909 standard design of 33-inch chilled car wheels for 60,000, 80,000 and 100,000-pound capacity cars is designed for a depth of chill of approximately ⅝, ¾ and ⅞-inch in the center of the treads of the 625, 675 and 725-pound wheels, respectively. The flange, plates and other parts of the wheels are supposed to possess the maximum of strength when made under correct temperature conditions, from an iron that will produce the prescribed depth of chill on the different size wheels. There may be a wide varia-

FIG. 1—INTERIOR VIEW OF PORTION OF A WHEEL FOUNDRY, SHOWING LARGE METAL RESERVOIR AND METHOD OF HANDLING MOLTEN IRON

tion in the chilling capacity of irons of apparently the same chemical composition due to the melting practice, occluded oxygen and other gases and the presence of small quantities of the rarer elements not usually considered in analyses for furnace control, so that both the composition and molding practice must be adjusted to suit conditions peculiar to each individual foundry to obtain the best results. However, as a general rule, wheels should be poured from hot metal, at the rate of not less than 55 pounds per second, or as much faster as molding conditions will permit; they should be shaken-out of the sand as soon as the metal has taken a permanent set throughout and will permit of handling. They should be transferred to the annealing pits as soon as possible after being removed from the sand and should be cooled (annealed) at a constant rate of temperature decrease. The molds should be made from medium coarse or open sand, of even temper and evenly rammed throughout so as not to cause hard spots at different places on the wheel, specially on the thin sections.

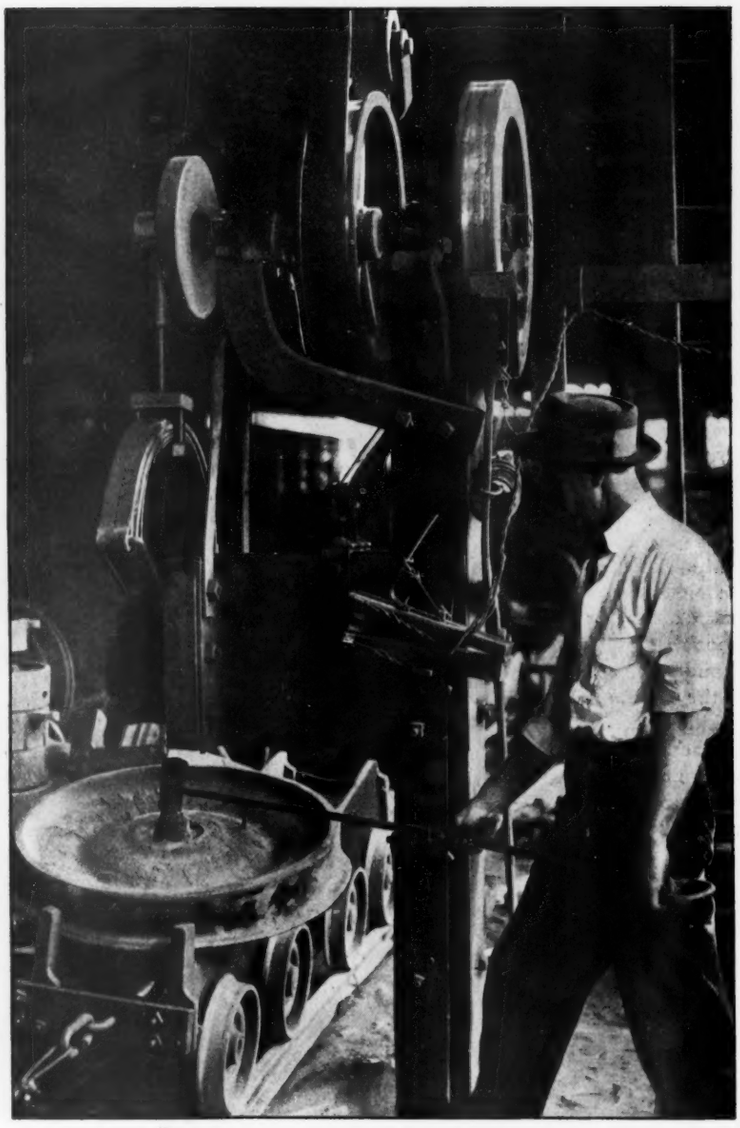


FIG. 2—POWER-OPERATED HAMMER FOR KNOCKING OUT SPRUES OR CENTER GATES

The preceding articles of this series dealing with the mixture and melting practice, respectively, at the wheel foundry of the Lenoir Car Works Lenoir City, Tenn., showed how present methods were determined upon after systematic experiments and the same is true with reference to the molding practice of this plant.

Different kinds of chillers for the wheels, especially the contracting type, were experimented with at various times, but it was found that the plain chiller was more economical and that apparently equally good results could be obtained with it as with the contracting type, so that the plain chiller is used in regular practice.

Different methods of molding, especially of gating the wheel, were tested and after considerable experimenting the method illustrated in Fig. 3 was adopted. From this it will be noted that the sand dish or pouring basin is so arranged that the molten metal is made to whirl as it goes into the mold, which tends to keep any slag or other impurities in the head metal. The feed gate passes through the center core and into the mold through three runner gates, shown at the bottom of the center core, each having an area of 1¼ square inches and which, when properly poured, will feed the mold at the rate of approximately 55 pounds of molten metal per second, or will run the 625, 675 and 725-pound wheels in 11.4, 12.3 and 13.2 seconds, respectively. Fast and uniform pouring is essential to good wheel practice, as slow pouring — or pouring with dull iron, which is the equivalent — besides causing chill cracks, wrinkle treads and other surface defects, is the prime cause of internal throat seams or "blue fracture seams", as they are sometimes called, and which are responsible for the greater part of flange failures that actually result from defective cast iron wheels. The chemical and physical analysis of the sand used for making the molds is given in Table I. This sand was selected after making comparative tests of a number of molding sands in this district by using them on separate floors over a short period and noting the results obtained with each. Coarse river sand is used for making the ring or pan cores. This is purchased on specifications which are given in Table III. Coarse, open sand is essential for making these cores successfully, as they require considerable strength, must be soft, so that the iron will lay well

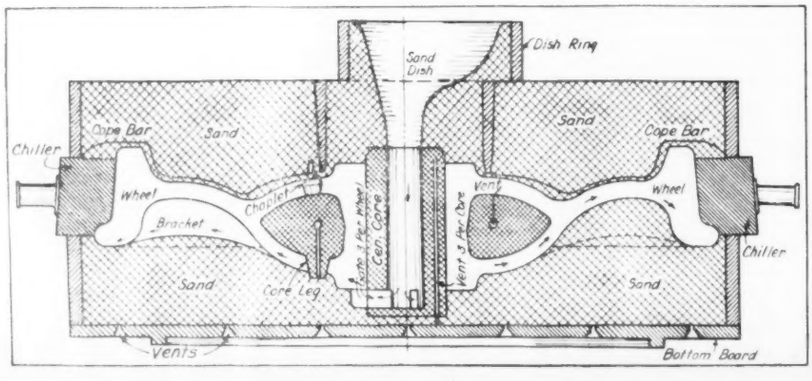


FIG. 3—SECTION OF WHEEL MOLD, SHOWING METHOD OF MOLDING

to the core and permit of only limited venting. By buying extra coarse sand it was found, after some experimenting, that by adding small quantities of old sand to the mixture each day and increasing the amounts daily, it was possible to use one-half old sand, which resulted both in a better core and a considerable reduction in core costs. Vent wires are used in the smaller cores, but these are not required in the larger ones, and to aid in taking off the vent, a layer of fine coke extending around the center of the core and opening into the down vents is used. This does not impair the strength materially and has proved successful in the larger cores. The center core is made closer and harder and after being dried, is dipped into a core wash made of glutrin water thickened with mineral facing, which forms a protective coating over the core, preventing the molten metal from cutting the core in passing through the gate, in addition to making a clean, smooth hub. Flour is used as a core binder. This also is purchased on specifications given in Table II. According to the specifications, this is an extra high grade flour for foundry use. However, flour of this grade can be obtained in this territory at a premium of approximately 10 cents per 100 pounds above ordinary foundry flour and it possesses approximately double the binding power. It also was found to be more economical than any of the core compounds ordinarily recommended for wheel work and included in the comparative tests, as reported in a paper by the author, entitled "Relative Value of Foundry Flour and Simple Methods of Testing", read before the American Foundrymen's Association at its Buffalo meeting and published in Vol. 22 of the *Transactions* of this society.

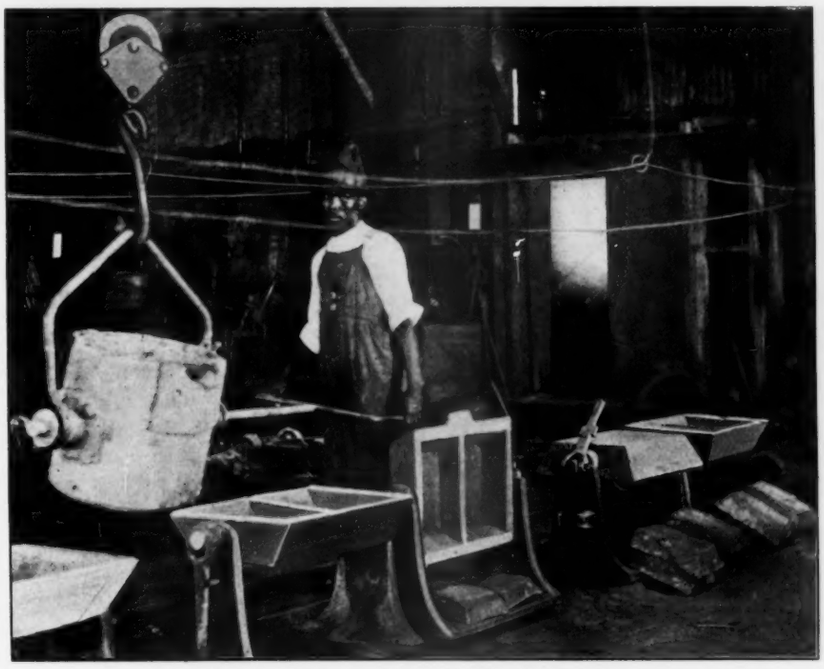


FIG. 4—PERMANENT MOLDS FOR CASTING OVER-IRON INTO PIGS

The mixtures used in the different cores follow:

PAN CORES

20 Parts new river sand; 20 Parts old sand; 1 Part flour (by weight).

RING CORES

12 Parts new river sand; 6 Parts old sand; 12 Parts molding sand; 1 Part flour.

The chaplets are made of wheel iron, molded each day for use on the following day, so that they are always free from rust or dampness and do not require a protective coating. These are made with the equipment illustrated in Fig. 7, at a nominal labor cost of 50 cents per thousand.

A floor plan of the wheel foundry is shown in Fig. 5. From this it will be noted that the straight floor

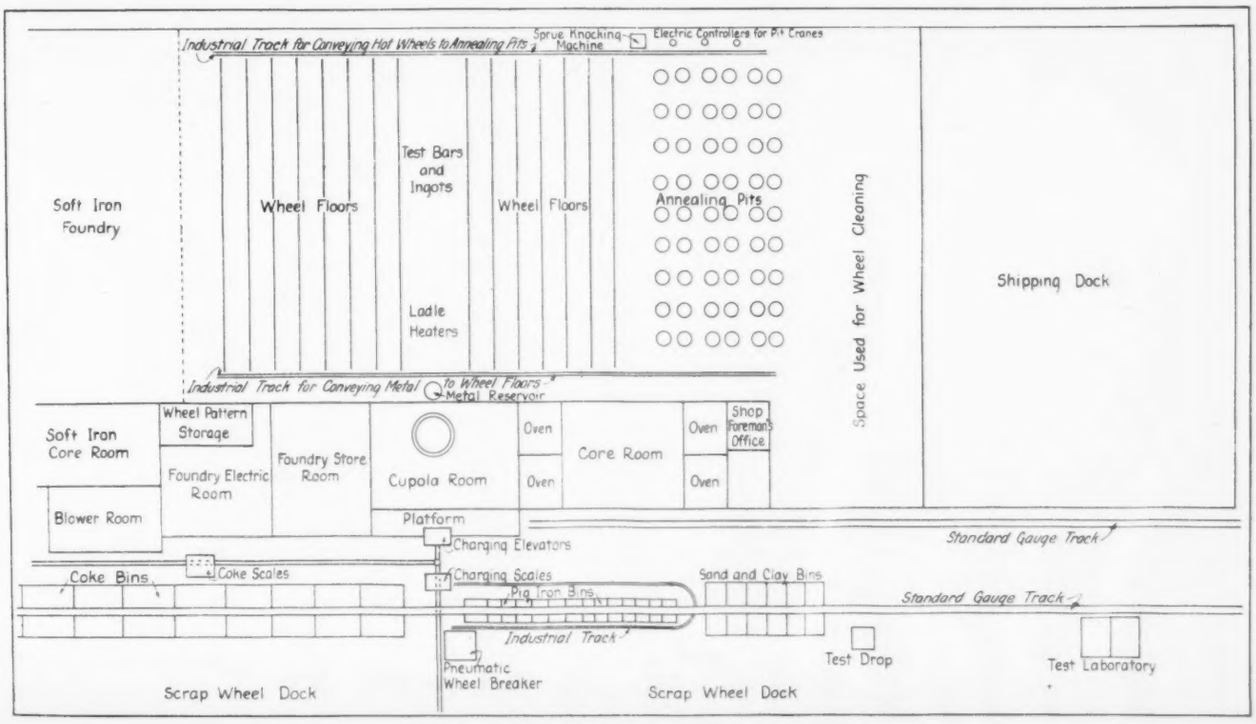


FIG. 5—FLOOR PLAN OF WHEEL FOUNDRY

system is used. The foundry has 15 floors, each served by an electric hoist and traveling crane; the shop is divided into two divisions of seven and eight floors, with the cupola and metal reservoir at one side, midway between the two divisions. This arrangement brings all of the floors as near the cupola as possible, thereby reducing to a minimum the time required to convey the molten metal from the furnace to the molds. The space between the two divisions is used for preparing the pouring ladles, casting the chill test ingots and transverse test bars, chaplets, etc., and for making thermal tests.

The molten iron is conveyed to the molders by electrically-controlled cable buggies operating on an industrial track, which passes in front of the metal reservoir or storage ladle, which also is electrically-controlled, where the individual wheel ladles are filled and pass onto the molder at the end of the floor nearest the ladle. Two molders pour at one time, four ladles being in use, so that two are being filled while the others are being emptied. This arrangement is shown in Fig. 1, which is an interior view of a portion of the foundry. The storage ladle, which also is a mixing ladle, is shown in the center background with a wheel ladle in position for receiving the metal. At the left are two empty ladles, swinging from the floor cranes, ready to be exchanged. With this arrangement, one man who operates both the ladle and conveyor, delivers metal to the molding floors at the rate of two wheels per minute.

The two molders who pour also shake-out the wheels and deliver them to electrically-controlled cable buggies, operating on an industrial track at the opposite end of the molding floors, which convey them to the annealing pits. Stationed over this track is a small Bradley hammer, illustrated in Fig. 2, which was designed and built by the company for knocking out the sprues. These were originally knocked out with sledge hammers, which was a very difficult job. The use of the power hammer materially shortens the time that the wheels are exposed to the air, in addition to eliminating the services of one laborer. After leaving the sprue knocker, the wheels pass under the electric pitting cranes, which are of the double-cable type, so that two wheels are pitted at one operation. With this arrangement the wheels are transferred from the sand to the annealing pits in a minimum of time.

Table I.

CHEMICAL AND PHYSICAL ANALYSIS OF MOLDING SAND

Fineness (Physical)

		Per cent.
Passing	20 mesh	100.00
Passing	40 mesh	98.90
Passing	60 mesh	81.70
Passing	80 mesh	59.20
Passing	100 mesh	51.00

Analysis.

Water	4.40
SiO_2	85.92
Al_2O_3	7.63
Fe_2O_3	2.57
CaO	....
MgO	....
Alkali	Trace
Clay	19.33

Table II.

SPECIFICATIONS FOR FOUNDRY FLOUR

The material desired under this specification is a starchy wheat flour, free from all adulterants either vegetable or mineral and must conform to the following detail specifications:

1—Physical Properties:
Should show a smooth surface free from appreciable amount of visible bran particles when slicked-out with a smooth paddle or spatula and examined with the naked eye at a distance of 15 inches from the slicked surface. Must be free from musty odors.

2—Chemical Composition:

	Per cent.
Mineral matter or ash must not exceed	1.35
Crude fat or ether extract, must not exceed	2.50
Crude fiber, must not exceed	1.25

3—Each car load shall be considered a unit. Samples of one pound each will be taken from each 5,000 pounds of the shipment, the samples added together and thoroughly mixed and the resultant samples represent the shipment.

4—The chemical composition will be determined according to standard methods, and should the sample fail to comply with the above requirements the shipment will be rejected.

5—All rejected material will be held subject to shipper's disposition and the shipper shall assume all charges on rejected material.

6—All shipments to be made in jute bags unless otherwise specified.

Uniformity of Practice

Rapidity of handling both the molten iron and hot wheels and uniformity of practice, including the temperature and rate of pouring the wheel; time that the wheel is left in the sand or temperature at which it is shaken-out; time that it is exposed to the open air and temperature at which it goes into the annealing pits; all are essential to the production of uniformly strong wheels. Any variation from the normal practice, such as holding the metal in the ladle too long, slow pouring, shaking-out either too hot or too cold or allowing the wheel to remain exposed to the action of the cold air too long is liable to produce a freak wheel or what is sometimes called an "individually weak wheel". This is the only point the exponents of the steel wheel can rightfully make in preferring it to cast iron, as the normal iron wheel has adequate strength to meet the demands of present-day service. In addition, the peculiar characteristics of the tread of the iron wheel are better adapted to withstand, without injury to the wheel itself, the abrasive action of the brakes, yet it possesses a higher coefficient of friction than the steel wheel, and under similar conditions produces less wear upon the rails. These advantages, with its low initial cost as compared to the steel wheel, make it an economical piece of rolling stock.

The elimination of the freak wheel is the greatest problem before the wheelmakers today. Realizing this fact and its dangers, we instituted what might be called a "follow-up system".

Beginning with the charge, a complete record is kept of each wheel, including the mixture, the amount and condition of coke used between each charge; condition of the atmosphere and the blast pressure recorded between each tap or casts; the relative temperature of the metal of each tap, whether hot, good, fair or cold, and the size of each tap, *i. e.* the number of wheels poured from it. A chill test ingot is made from each tap, which indicates the chilling capacity and other properties of the metal, and if, as is sometimes the case, the molten metal is treated with ferro-alloys for reducing or increasing the chill, the kind and amount used in each wheel is recorded. The part of the tap or cast from which the wheel is poured, the position the wheel occupies in the annealing pit, whether at the bottom or top also is recorded. If a wheel or wheels are delayed in shaking-out or any other irregularities occur from mechanical or other causes, the facts are noted.

The wheel ladles are heated with fuel oil at the beginning of the heat, but in the case of a burn-out or other failure, when a green ladle is put into service, this is noted on the records of the first wheel poured with it.

As a rule, about three tons of metal are left over in the storage

Table III.

SPECIFICATIONS FOR RIVER SAND

All shipments of river sand for foundry use must meet the following requirements:

1—Must be free from clay, silt and organic debris such as weeds, pieces of wood and leaves.

2—Fineness:
Not more than 85 per cent by weight shall pass the No. 20 mesh sieve.
Not more than 5 per cent by weight shall pass the No. 60 mesh sieve.
Not more than 1 per cent by weight shall remain on the No. 2 mesh sieve.

3—Shipments of sand failing to comply with these specifications will be rejected and the shipper will be held responsible for all transportation charges.

ladle or mixer at the conclusion of each heat and the amount left over is recorded. This is done to prevent wheels from being poured from the last iron in the ladle, which is liable to be cold and consequently this will result in weak wheels. This over-iron is cast into pigs, using the permanent molds illustrated in Fig. 4. These are dumped and refilled as fast as the metal sets, so that only a small number is required to take care of a considerable amount of iron as fast as it can be handled.

All of the preceding records except those pertaining to the mixture and coke charges, which are kept on separate forms, are noted on the Individual Molder's Card, illustrated in Fig. 6.

Each molder is furnished with one of these cards daily, showing the weight of the wheel to be made, core dimension and numbers to be used by him for that day. As soon as the molder has finished putting up his work, and before the heat begins, the cards are gathered up by the record clerk, who follows up each stage of the work and fills in the records as the heat proceeds.

To one not familiar with the system, the records shown on this card would appear unintelligible, but, in fact, they are both complete and simple. For example, consider wheel No. 5081, listed in the first line of the fifth column (from left to right). At the top of this column "Cast 2" is noted, which means that this molder was the second to cast or pour. Following the first line through from left to right, it shows that this wheel was poured from the first tap in the heat, which had a chilling capacity of 1¼ inches on the chill test ingot, that the temperature of the iron was good and the wind or blast pressure 8½ ounces. It shows that this was the last wheel poured from the first tap, as the molder only poured one of the seven wheels, constituting the first cast, out of this tap. He finished his cast out of the next tap being the first to have iron and then wheel No. 5080, shown in the second line, was the first wheel poured from the second tap, and so on. On the ninth line from the top the words "Test Ingot", appearing in the right-hand column, indicate that the sample for the analysis was taken from the eighth tap. Following down to the thirteenth line, it shows that the power was shut-off for 10 minutes just after wheel No. 5070 was poured. Following down to the eighteenth line, it shows that wheel No. 5064 was a top wheel in the annealing pits. At the conclusion of the heat the

1-16-15 5M C 44125 Form 59

Wheel Heat Record

Moulder F. E. Sherrod Floor No. 8

For SOUTHERN RY.

DATE CAST JUN 22 1915 Cast Style 675 Core 6"

Tap	Chill	Condition of Iron	Pres.	Serial Numbers	Alloys	REMARKS
1	1 1/4"	Good	8½	5081		
2	1 1/4"	"	9	80		
"	"	"	"	9		
"	"	"	"	8		
"	"	"	"	7		
"	"	"	"	6		
"	"	"	"	5		
7	1 1/4"	"	9	4		
8	1 1/4"	"	9	3		Test Ingot
"	"	"	"	2		
"	"	"	"	1		
"	"	"	"	70		Power off
"	"	"	"	9		10 Minutes
9	1 1/4"	"	9	8		
15	1 1/4"	"	9	7		
16	1 1/4"	"	9	6		
"	"	"	"	5		
"	"	"	"	4		Top wheel
"	"	"	"	3		
"	"	"	"	5062		

FIG. 6—INDIVIDUAL MOLDERS' CARD

cards are filed in the shop foreman's office, until the wheels come out of the annealing pits and are cleaned, when they are used to check over each individual wheel, as will be explained in a later article dealing with the Annealing and Shop Inspection. This method of keeping records of the manufacture of each individual wheel was started about four years ago, and has been gradually enlarged and improved upon as experience would indicate. It has proven of great value in shop control and especially in looking up records of wheels that have shown defects in service. It has been the means of showing up the freak or individually weak wheels and enable us to eliminate these.

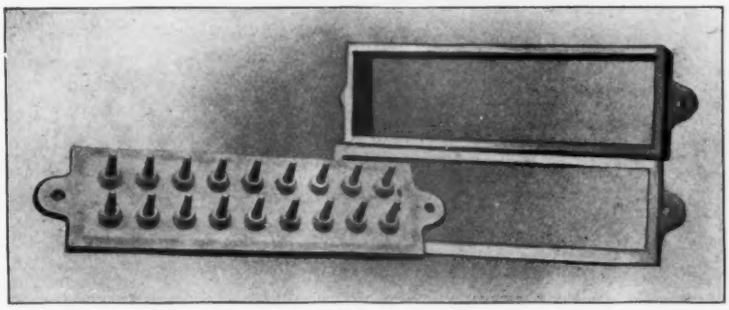


FIG. 7—MATCH-BOARD AND METAL FLASKS FOR MAKING CHAPLETS

Molten Iron Boiling in Ladles

By W. J. Keep

Question:—We are anxious to learn the cause of agitated metal in our ladles and molds. Our cupola is lined to 60 inches, the charges consisting of 3,000 pounds of iron and 300 pounds of coke. We use 2,000 pounds of coke on the bed, which brings the coke charge to a point about 30 inches above the tuyeres. All charges are of the same size except the last, from which the coke is omitted. We charge 1,800 pounds of pig iron, 1,150 pounds scrap and 50 pounds of steel scrap. We use also 100 pounds of limestone as a flux after the second charge and run slag and iron continuously after starting. The blast pressure is 14 ounces and we melt about 40 tons in four hours. Our iron analyzes as follows: Silicon, 2.05 per cent; phosphorus, 0.53 per cent; manganese, 0.55 per cent and sulphur, 0.07 per cent. The iron is sufficiently hot but it boils violently at times.

Answer:—Your entire difficulty can be traced to your ladles, as the boiling of iron in the ladles is due to moisture. It is evident that the ladles have not been dried sufficiently and we believe that you will find that the iron does not boil after the first catch in any case. Iron that has boiled is liable to make hard castings and, therefore, it is best to pour the first catch into work that is not to be machined. It is customary to pour the first catch into another fresh ladle so as to dry two and then to pour this iron into the pig bed. Many years ago the fact that melted iron rose rapidly at the sides of the ladle and flowed toward the center gave rise to the theory that iron expanded and became lighter as it cooled, but careful investigation proved that the motion of the iron was caused by moisture. Iron poured into a fresh, perfectly dry ladle also will boil because there is always material in the daubing which forms gas when hot iron lies against it. Generally, this material is so burned and dried by the first ladle of iron that it will not cause the boiling of the iron poured into the ladle subsequently.

W. E. Harvey, who has been associated with the Diamond Rubber Co. and the B. F. Goodrich Co., Akron, O., for 11 years, has been appointed sales manager of the Boston Belting Co., Boston, manufacturer of mechanical rubber goods.

The Application of Scientific Management---I

An Explanation of the Purposes and Accomplishments of Scientific Management—How it Can Be Utilized to Best Advantage in the Foundry

By H K Hathaway

IN SPITE of the wide publicity that the scientific management movement has received, there is so much misunderstanding as to what scientific management really is, what its advocates aim to accomplish through its application, and how it is applied, that a brief explanation on each of these points is necessary in order that the plan I propose may have a proper background.

Scientific management must not be considered merely as a means of securing greater dividends for the stockholders, but rather as a means to the general betterment of human welfare. It is true that under present social and economic conditions, as Frederick W. Taylor said in a statement that has been misapplied by his opponents, "the chief object of any company must be the earning of profits for its owners". It is self-evident that unless this object is accomplished, sooner or later the company must fail. This is one of the objects of scientific management, but not the only one, nor was it regarded by Mr. Taylor as the greatest. Did scientific management accomplish no more than this it would be a failure, but without doing so it could not, under the existing economic system, accomplish those bigger objects upon which the earning of profits are in turn dependent. Broadly speaking, scientific management is intended to produce more wealth for a given expenditure of effort, as a result of elimination of waste in the matter of time, work and materials. Mr. Taylor in his lectures was wont to emphasize the fact that wealth in usable form only comes into existence through the efforts of those who are to enjoy it. The producer and consumer, broadly speaking, are the same person, and by consequence any increase in production of useful articles cannot help but benefit the producer.

In his preface to the French edition of Mr. Taylor's book, "The Principles of Scientific Management", Mr. Henri Le Chatelier, the famous scientist, says:

Let us suppose for an instant that the belief in economic determinism has become general, and let us endeavor to unravel some of its laws. Here, for example, is the first one, extremely simple, too evident even, you will say, to be worthy even of mention:

In civilized countries men have a great desire for enjoyment, seeking all of the pleasures of life and being disposed to put forth considerable effort in order to procure them.

Restraint in civilized lands is indispensable. Often the negroes of the African tribes content themselves with the most rudimentary habitations, go without clothing, and have as their sole ambition, to lead a vegetative life basking idly in the sunshine. Such countries have their own peculiar economic conditions.

On the contrary, in civilized countries, the desire to enjoy the pleasures of life, each day more numerous, to possess worldly goods in greater number, to gain more money because in exchange for money may be procured all of the enjoyments sought, is certainly the most powerful motive capable of producing activity among mankind. One is stupefied to see the amount of work that the small farmer or the workman who owns his own house will do when he is certain of not having to divide the fruits of his labor with anyone. In that lies a certain truth, an economic law. In spite of its simplicity and its self- evidence, it is not out of place to mention it in consideration of the consequences that it entails.

Here is one of these consequences which constitute itself a second law, no less certain than the first, but yet less generally accepted. Its importance is enormous from the workman's standpoint:

The inhabitants of any civilized country become twice as rich each time that they succeed in doubling their production because they have then each one on the average two times the things, useful or agreeable, to consume.

This truth, this law, is again so evident that there should be no need of justifying it. In a country where each inhabitant produced everything to satisfy his needs no proof would be possible; this law then would apply equally well to savage tribes as to civilized peoples. It was formerly thus in France; the peasant produced on his land the wheat necessary for his food; he next ground it and made it himself into bread. He raised also a pig which he killed and salted for his winter provisions; he cultivated flax from which he spun and wove his cloth; he hewed also the wood of which he built his house and grew the straw with which he thatched it. In increasing his production as is made possible today by the employment of agricultural machinery he has obtained a much higher return from his labor. The sale of this surplus of his production has made it possible for him to replace the hut of his fathers by a solid house of stone roofed with slate instead of straw. His installation in this luxurious abode will remain for him the greatest joy of existence and lighten all his troubles.

If our farmers and our textile workers succeed today in producing together by grace of this specialization twice the quantity of useful articles as in the past they will each be able to procure, whether directly or by exchange twice as much as formerly, and they shall therefore have become twice as rich as formerly.

There is, however, a reservation to be made here; it does not suffice in the case of specialization, that one isolated individual should double his production in order that he may become twice as rich; it is still necessary that his neighbors should do as much, otherwise he would have no one with whom to exchange the products of his labor, which would then do him no good. There is in that an essential condition of the law of proportion between the increase of production and that of riches.

One often hears it said that increased production is not necessarily followed by increased consumption, that it is necessary to avoid exceeding the power of absorption of the consumer. In reality there is no limit to this power of absorption, at least in civilized lands, because neither is there a limit to the desire of well-being. This is a truth that it is necessary to proclaim incessantly and which everybody should be made to see.

So long as this truth is not recognized, the ideas advanced by Mr. Taylor will not be appreciated at their just valuation because their one object is to increase the productive power of every man. Machinery, although employed too often without method, has already produced enormous results in this direction. Within a century the production per man has been increased about tenfold through this agency, and in consequence mankind is ten times richer. The methods proposed by Mr. Taylor make it possible, without any change in present machinery, to double again and in some cases to triple the production of each workman and consequently to double and triple wealth generally. How does it happen that a law so useful and so important, which should be well-known, should be so generally unrecognized and contested? The explanation must be looked for in the multiplicity of errors of human judgment. Instead of relying upon simple common sense people are prone to enter into long calculations that are completely wrong, or on the

A paper read at the twentieth meeting of the American Foundrymen's Association, Atlantic City, N. J., Sept. 28-Oct. 1. The author, H. K. Hathaway, is affiliated with the Tabor Mfg. Co., Philadelphia. This is the first of two installments.

other hand let themselves be guided by unreasoning sentiment.

This essay of Mr. Le Chatelier's is the clearest and best exposition of the economic importance of the scientific management movement, and one which ought to be read by all workmen and all employers.

Scientific management seems to be inevitable. Labor is constantly demanding a larger portion of the wealth produced; the standards of living of the great mass of the people are advancing; workmen want better homes, better clothing, better food, to raise their families in greater comfort, and to give their children better opportunities for education. In addition to these they should have enough to properly provide for their sustenance and comfort in their declining years. In short they want higher wages. Having secured the higher wages, the next thing Labor wants is more leisure for recreation, for the enjoyment of the wealth produced, and for self-development—or shorter hours.

While, at times, we may have our viewpoint twisted by local conditions, or by the means taken to secure the desired result, we must admit that there is a great deal of justice in Labor's demands—as they are in fact only what we are all striving for.

Sooner or later these demands must be met. But how? No one can logically object to workmen receiving higher pay—either in the form of more dollars or lowered cost of living—nor to their working shorter hours, provided society as a whole does not suffer thereby. It must not be forgotten, however, that society is very largely composed of workmen, and that if we simply raise wages and shorten hours without correspondingly increasing production, the result will simply be to diminish the purchasing power of the dollar, as everything will cost more, and society—including the workmen—will be in a worse condition than before. Where then are the higher wages and shorter hours to come from? An arbitrary shortening of hours without a proportionate increase in production would wipe a great many industries off the map, unless they increased selling prices to offset the higher cost. If this latter expedient is resorted to, the burden falls upon the consumer—who is in the last analysis the workingman — and he profits nothing by his apparent gain.

Time Study Covering Three Days Work in a Foundry

Fifth Day

Started with "Angelo" and "John", both new to their jobs.

A. M.	A. M.	
7:00 to	7:40	Cutting sand.
7:40 to	7:47	John to toilet.
7:47 to	8:35	16 drags made. About 2 minutes, 43 seconds each.
*8:35 to	8:38	Angelo gets slick from old place in shop.
*8:38 to	8:40	Both men get blacking from benches in foundry.
8:40 to	9:05	Patching and blacking 16 drags.
9:05 to	9:09	One man sets 16 small cores while other man continues to patch and black.
*9:09 to	9:10	One man gets fresh supply of blacking, while other continues to finish molds.
9:10 to	9:17	Both men nail 15 small cores with 2 nails each.
9:17 to	9:25	Both men set 11 large cores and vent each one at 5 points.
9:25 to	9:32	Changing pattern board.
*9:32 to	9:33	Getting vent wire on account of not understanding that this was not necessary.
9:33 to	9:43	Making first cope. Learning where nails were to be set, etc.
9:43 to	9:50	Adjusting pouring basin on pressure block.
9:50 to	10:20	Making 3 more copes.
*10:20 to	10:23	John gets clay and mixes it in clay wash for nails.
10:23 to	11:08	10 more copes made. 4 minutes, 30 seconds per cope.
11:08 to	11:18	2 more copes made.
11:18 to	11:50	Finishing copes.
11:50 to	11:55	John left for somewhere.
11:55 to	12:00	Finishing copes.

P. M.	P. M.	
1:00 to	1:55	Finishing and setting five cores in drags.
1:55 to	2:00	Blacking and blowing out molds.
2:00 to	2:07	Tipping up copes and cleaning out basins.
2:07 to	2:21	Closing 16 molds.
*2:21 to	2:26½	Getting facing sand.
2:26½ to	2:28	Changing pattern.
2:28 to	2:31	Getting bull ladle and building fire in it.
2:31 to	3:00	Making 8 drags.
3:00 to	3:03	Changing pattern board.
*3:03 to	3:28	Trouble with pattern. Lost three molds and finally saved one by careful patching. Allow 6 minutes machine time.
*3:28 to	3:40	Patching eight drag molds.

Molds made 20½. Time on machine, 3 hours, 11 minutes. Average, about 6½ molds per hour.

Sixth Day

"Angelo" and "Luigi", both new to their jobs. On previous day Angelo worked on opposite side of machine.

Started work with 8 drags and 1 cope on the floor.

A. M.	A. M.	
7:00 to	7:30	Cutting sand. (10 minutes less than on day before).
7:30 to	8:04	Seven copes made.
8:04 to	8:30	Finishing these 7 copes.
8:30 to	8:38	Closing 8 molds.
8:38 to	8:42	Changing pattern.
8:42 to	9:27	Making 15 drags, 3 minutes each.
9:27 to	9:41	Finishing these drags.
9:41 to	9:47	Adjusting block on ramming head.
9:47 to	10:06	Making 3 copes.
10:06 to	10:20	Making 3 more copes.
10:20 to	11:10	Seven copes made.
*11:10 to	11:20	Trouble with flasks not fitting pattern board.
11:20 to	11:29	Two copes made.
11:29 to	12:00	Finishing these copes.

P. M.	P. M.	
*1:00 to	1:35	Finishing copes. No cores at hand as promised.
1:35 to	1:45	Luigi gets more black sand. Angelo continues to finish molds.
*1:45 to	1:55	Luigi (new man) spoils cope. Angelo patches it.
1:55 to	2:00	Removing basin from pressure block on machine.
2:00 to	2:32	Making 10 drags.
2:32 to	3:00	Closing molds.
3:00 to	3:30	Making 5 copes.
3:30 to	3:40	Closing same.

Twenty-eight molds closed on floor and six extra drags and one extra cope which could not be closed because of flask pins.

Molds made, 26. Time on machine, 4 hours, 13 minutes. Average 6.2 molds per hour.

Seventh Day

A. M.	A. M.	
7:00 to	7:30	Cutting sand.
*7:30 to	8:15	Cleaning out sand under machine.
8:15 to	10:30	Forty-four drags made.
*10:30 to	10:40	(Allow 3 minutes machine time). Grinding corners off pattern board and adjusting pattern board in place.
10:40 to	12:00	Making 23 copes.

P. M.	P. M.	
1:00 to	1:20	Angelo and Luigi make 2 copes.
1:20 to	3:00	Twenty-six more copes finished. Trouble and delay all through this time because the flasks that were brought to machine did not fit pattern board.

50 open molds on floor.

Molds made, 46½. Time, 5 hours, 21 minutes. Average about 8.7 molds per hour.

Average time for various half molds made. These times can be considerably reduced by practice:

	Time Each Minutes.	Seconds.
Pattern "A" Drags	2	43
Pattern "A" Copes	4	30
Pattern "B" Drags	3	35
Pattern "B" Copes	4	54
Pattern "C" Drags	2	37
Pattern "C" Copes	4	8

I believe these times can be reduced to an average of three minutes per half mold.

The items marked * indicate points at which production was lost through faults which the workman had no control. A more minute and properly made time study with a sufficient number of observations—such as will be shown later—would have probably indicated numerous small difficulties which if corrected would result in considerable gain in output.

The same is true of an increase of wages without an increase in production. You can't get something for nothing. Even if all of the profits earned by the average company were distributed among the workmen it would not make any very great difference in their pay, especially if the years devoted to the building-up of a business and years of industrial depression are taken into account.

The earning of profits is, under the existing state of affairs, essential to the life of our industrial organization. Where then lies the solution? Perhaps the first and most important thing—although it will probably be the last to be accomplished — is the stabilization of business, the wiping out of constantly recurring periods of *hard times.* This is, however, too big a subject to go into now. A more practical solution — although it will never be an absolute one as long as we have business depressions—lies in the general adoption of scientific management. The development of machinery has been the means of the great improvement in the condition of society that has taken place during the last century and a half; scientific management, which is the complement of machinery, is the next step, and will make possible the payment of higher wages and shorter hours without decreasing production or increasing cost.

Opposition to Scientific Management

Scientific management has, even as labor-saving machinery or indeed any progressive movement, met with opposition which has not by any means been confined to the workingman or their champions.

Much of this opposition has been due to misunderstanding or to abuses committed in the name of scientific management. Misunderstanding is gradually being cleared away, but the abuse referred to is harder to cope with. A man whom I greatly admire and respect, who has spent many years in an honest and tireless endeavor to improve the condition of labor, recently wrote me as follows:

I read the debate which occurred relative to the riders attached to the Army Appropriation Bill. I feel certain that had I been in Congress I would have voted in favor of them, not for any opinion that they settled the question or that they decided the merits of any question involved through scientific management, but that it would force a more thorough study of the entire question.

I do not believe that there is sufficient knowledge on the subject and I feel that those who favor or oppose scientific management must discuss their respective attitudes more thoroughly and publicly than they have, before anyone is in a position to speak a final word.

Since leaving you I have seen much which interested, amused and grieved me, and on more than one occasion I said: "If Hathaway could only see this he would have a fit and somebody would be expelled for heresy."

I found many conditions existing in plants which claim to have applied the methods of scientific management which were in direct opposition to the principles laid down by Mr. Taylor and those which you have talked over with me, and one of the most depressing facts which was most evident is that the woods are full of incompetent men and charlatans who, because the field seems to be a promising one, are out gathering in the shekels from those who have employed them. I feel that these men who are quite large in numbers, are far more dangerous to scientific management than anything else.

I want to assure you that had you seen some of the second and third rate men whom I have watched making time studies and setting tasks, you would realize the necessity of some such step being taken as much so as if you had witnessed, as I have done, the work of some men professing to be efficiency engineers and received comparatively enormous salaries. These men, are, without doubt, acquiring some information as they blunder along, and it is doubtful who bears the heaviest burden of their experiments, the employers or the workmen. I have seen plenty of instances where one or the other or both were being flim-flammed. As one man standing fairly high among the group of those who advertise their business of efficiency engineers said to me during a conversation—"What in h—l do you think we are. There may be a whole lot of talking about our benefiting the workmen, but the employer is in business for the money and we are in the business for the money. When we feel that we are not in the business for the money that's in it, we will get out". You see it is not only what the words may imply but the spirit which lay back of it and so long as men with such ideals are endeavoring to introduce new systems, so long is it most certain that there will be industrial friction whether the workers are organized or unorganized.

This sort of thing, of course, is an obstacle in the advancement of scientific management, but as employers and workmen learn more about the subject it will disappear. The essence of scientific management is summed up in four great principles; Mr. Taylor states the four basic principles in his book "The Principles of Scientific Management" in such a concise manner that it is not until he has studied the subject exhaustively and become quite familiar with it through intimate contact that the average person grasps their full meaning and importance. These basic principles are as follows:

1.—The development of a science in place of "rule-of-thumb" knowledge. This means scientific investigation and study; the collection and codification of data and their reduction to laws. In this *time study* plays an obviously important part.

2.—The scientific selection and training of the workman in place of workmen being employed as a result of expediency, necessity, or mistaken personal preference on work for which they may be physically, temperamentally or mentally unsuited; or, as Mr. Taylor expresses it, "in the past he (the workman) chose his own work, and trained himself as best he could". Improper selection of the workman has resulted in many *square pegs in round holes.*

3.—Hearty co-operation between the management and the men, so as to insure all work being done in accordance with the principles of the science which has been developed.

4.—An almost equal division of the work and responsibility for results between the management and the workmen, the management taking over all of the work for which they are better fitted than the workmen; in the past almost all of the work, and the greater part of the responsibility were thrown upon the men.

Important as these principles may be, it is not enough to simply set them forth. While they may be applied by anyone in any undertaking employing a number of people without any formally laid down system, if they are to be consistently and permanently adhered to, a properly devised and installed mechanism becomes a necessity. To the development of such a mechanism Mr. Taylor devoted the greater part of his life.

Time will not permit of any detailed description of the system developed, the form of which varies in different industries. I must take it for granted that you are already familiar with it, and if not, and you wish to become so, I must refer you to Mr. Taylor's book, "Shop Management" and certain articles which you will find reprinted in a book on scientific management published by the Harvard University Press.

In conjunction with reading the books referred to, those who are sufficiently interested would get a still better understanding by visiting one or more of the plants where this system is in operation.

On a Voyage of Discovery

In discussing the application of scientific management to the foundry, I feel something like Columbus must have felt in his endeavors to interest the people of his time in the theory that another continent lay at the opposite side of the globe and that by sailing due west he would reach it. No one had ever demonstrated that it could be done. That scientific management may be profitably applied to the operation of a foundry is, so far as the writer knows, still to be demonstrated.

In certain quarters this statement may be questioned. I have no doubt that some of you have heard of cases where scientific management has actually been tried, and proved a failure. Others may know of foundries which claim to be successfully operating under scientific management; and I have no doubt that a considerable portion of my readers will admit freely and without wasting time or argument that it may work all right in a ma-

clining years. In short they want does not suffer thereby. It must not profits nothing by his apparent gain.

chine shop, but that it won't work in their business.

From this it must not be presumed that foundrymen have not given much study and effort to the subject of increasing efficiency, or that nothing has been done in the matter of systematizing foundry operation, but that so far such efforts have been sporadic and have not been carried on in a manner which would have, in the eyes of the late Frederick W. Taylor or those who were closely associated with him in the great cause to which he devoted his life, merited the name of scientific management in the same sense as would the accomplishments in other branches of industry.

In dull times, such as prevailed almost generally throughout the foundry industry during the past two years — when most plants ran only three and four days per week with a reduced number of workmen — any proposition to increase production will fall on deaf ears. In such times all that may be accomplished is to reduce the direct labor cost through producing enough more work in a given time. A part of this saving must go to the worker as his just recompense for the part he plays in effecting it, and another part must defray the cost of creating and maintaining those improved conditions in the absence of which the workman could not turn out the increased amount of work. Such saving as may remain under the circumstances is not sufficient, in view of the increased percentage of fixed charges and other indirect expenses due to decreased business, to justify the expense of developing and installing the requisite system of scientific management. In busy times such as we have known in the past and such as seem now to be before us the problem is how to fill orders.

When the existing plant becomes insufficient to handle the business there are two ways to proceed; The most common and most obvious thing to do would be to make an addition to the plant, but there may be some difficulty in financing such a venture and land may not be available, but assuming that these obstacles do not exist there is still a greater objection than either of them, namely the increase in plant necessary to take care of the business that may be secured in boom times adds just so much more burden to be borne in dull times.

I shall now very briefly outline a tentative plan for the application of the Taylor system, having in mind a large jobbing foundry.

At this point it might be well to point out that the system or mechanism for the application of the principles of scientific management differs widely in different industries, and even in different plants in the same industry.

The development of a system suitable for each of the different classes of foundries is something that may only be done on the ground under working conditions. Today I doubt, if a company decided to install the Taylor system, that it would be possible to find a man to undertake the work possessing the necessary knowledge of foundry practice and at the same time a sufficiently profound knowledge of scientific management, to say nothing of the experience, ability and temperament upon which its successful installation depends. It might be done in one of two ways: By an experienced foundryman working in conjunction with an experienced management engineer, or by an experienced foundryman — possessing the right qualifications—taking two or three years to train himself; this period to be spent in other industries in which the Taylor system is in operation.

Taylor System in a Jobbing Foundry

In a foundry we would have, in common with other industries, to establish a planning department, a stores system, a tool room; equipment would have to be put in good condition, standards established, and provision made for maintaining the standards. The work of the planning department would include, in addition to the ordinary clerical functions, inspection and repair of patterns received, and should have the necessary floor space and equipment for this. Patterns to be used would be brought to the planning department, inspected, and such minor repairs made as might be necessary. Next the work of molding would be planned and instruction cards written. In this connection the flask to be used would be looked up, cores ordered, and provision made for having on hand all rigging before issuing an order for the actual molding of the job, so that when the time comes everything necessary may be delivered to the molders' floor in good working order. The planning would include determining whether or not the job should go on a molding machine—if so, which machine—and the fitting up of the pattern for the machine decided upon. The man performing this function would necessarily have to be a thoroughly skilled and practical man. The need of a tool room has long been recognized in machine shops even where no claim is made to the application of scientific management, but without a properly organized and equipped tool room scientific management would be almost impossible of application.

In a foundry under this system the tool room would be fully as important a factor as in a machine shop. The tool room would have charge of the storage and issue of all flasks, as well as repair and alteration of them. It should be able at any time to tell just what flasks are in use, what are available, and where located. It should be able to supply all small tools, such as rammers, trowels, shovels, brushes, etc., and should be responsible for the inspection and repair or replacement of those tools which would constitute the molder's regular equipment.

Some effort has been made to work along these lines; that is, to have patterns looked over and fixed up, proper flasks and other equipment supplied in advance of work being given to the molder, even in foundries making no pretense to scientific management, but it is very difficult without organization and system to have it done consistently. Such things, it may be said, should be done by any competent foreman, but when one considers the multiplicity of duties falling upon the foreman of a foundry it is a great compliment to him that he succeeds in keeping the foundry running at all.

I know from experience that in a machine shop it is a physical impossibility for a foreman to do one-half of what is expected of him, and from what I have seen of foundries, the machine shop foreman has an easy job compared to his brother in the foundry.

To illustrate the importance of these points the following instances are cited. In one foundry I saw a flask measuring about 5 x 8 feet and 3 feet deep placed on a jarring machine, filled and rammed up in a remarkably short time, and then left standing on the machine 20 minutes while the molder and his two helpers went in quest of clamps and wedges to secure the bottom board; they would not have taken so long except that the first man whose clamps they stole caught them just as they were putting them on, making it necessary to start the hunt all over again.

It is not infrequent that one sees a pattern sent to the foundry in such a battered condition that it cannot be drawn without so badly damaging the mold as to require more time in patching than the whole operation should take.

The man running a jobbing foundry is naturally reluctant to spend money fixing up someone else's patterns, but it is my firm belief that he would profit by employing a first-

class patternmaker to regularly go over and fix up every pattern before it goes to the molder. Such things as this, and going over flasks to make sure that pins and bars are all right, seeing that bottom boards, clamps, gaggers, chaplets, etc., are provided, could probably be done to greater extent than is customary, even without attempting a complete installation of the Taylor methods.

I had not intended to enter into a discussion of the shortcomings of present day foundry management, but cannot refrain from citing a few examples that have come to my attention which serve, I believe, to illustrate the need for something better.

A few years ago C. E. Knoeppel wrote an article appearing in the *Engineering Magazine* describing in a rather humorous way the experience of a molder named "Bill" during his day's work, comparing the time his several jobs took to complete with the time that should have been taken had his work been better planned. Many of you have probably read this article, but if you have not, you ought to do so; you will find it not only amusing, but instructive if read in the proper spirit.

Molding Machine Salesman's Report

The following report from a salesman of a certain molding machine company describing his efforts to help out a customer, is interesting:

Arrived about 2:00 p. m. and went at once to the foundry. Next four days spent in getting acquainted with conditions in works and putting the following improvements under way:

a—New clamping device to hold pattern boards on machine. Saves about six minutes every time a pattern board is changed and prevents danger of injury to patterns.

b—Sprue stick for patterns and a basin on ramming block of machine to cut sprue hole and basin in cope during ramming operation. Saves one-half minute per mold.

c—Sand placed in more convenient location. Saves about one-half minute per mold.

d—Loose floor boards put around machine instead of boards nailed down. Saves at least one hour per week in cleaning out under machine.

e—Benches placed beside machine for tools, parting sand, etc. Save about one minute per mold.

f—Taught *team work* motions to machine operator "Charley", who quit because of size of sand pile being moved to machine.

All of these things could have been done without a man from the outside coming in to do them. It is no reflection on the foreman or superintendent that they were not done. Neither of them could possibly devote enough time to this one problem to work out its solution.

In a shop under scientific management there would be someone whose sole function is taking care of just such cases.

The accompanying table presents a very rough time study, that was made by the salesman. As a time study it is worthless, but it indicates certain delays which better planning and better service to the workman might have overcome.

I have not endeavored to describe in detail the planning system which would necessarily have to include some satisfactory means for the laying-out of work for each molder in advance, for the delivery of the patterns, flasks, etc., to him at the right time, for securing reports of each job finished and its inspection, and moving it forward from one operation to the next, as well as making it possible to see just how much work there may be ahead of each class, and a means of knowing just what stage has been reached in the completion of any lot of castings.

As already stated, the details of such a scheme would have to be worked out on the ground, and while a general scheme might be evolved which would serve as a basis for all foundries of a given class, experience teaches us that even in different foundries whose work is in general the same, certain modifications would have to be made.

The working out of such a system is in itself a big undertaking, and likewise is the standardization of conditions and equipment upon which the smooth operation of the system developed will depend.

The several cases of inefficiency cited are not intended to simply show how bad existing foundry management may be, but they serve to illustrate what it is necessary to do in the way of establishing and maintaining better conditions before a system of scientific management may be applied. Strange to say the results achieved under scientific management are dependent upon the establishment and maintenance of better working conditions, and at the same time the establishment and maintenance of better working conditions is dependent upon the system. Under ordinary management it is very difficult to keep things up to the required standard, but under scientific management, where the work is planned to be done in a definite way under certain definite conditions and using certain specified tools and appliances, there is a much greater pressure brought to bear on the management in the matter of maintaining proper conditions.

(To be concluded.)

According to a bulletin issued by the American Iron and Steel Institute the tonnage of steel castings produced in 1914 was 693,246, as compared with 1,020,744 in 1913. The 1914 total was smaller than that of any year since 1911; 1907 was the previous year that surpassed 1914, when 803,117 were made.

Book Review

Hendrick's Commercial Register of the United States; twenty-fourth annual edition; 1,503 pages; 7 x 10 inches; bound in leather; published by S. E. Hendricks Co., Inc., and furnished by *The Foundry* for $10.00 net.

The latest edition of this important commercial directory has been thoroughly revised and an effort has been made to eliminate all of the dead wood and information which may have become obsolete. Much new information has been added and the lists of names and classifications have been corrected and brought up to date. The entire book has been reset and a leather binding adopted for the present edition instead of cloth, as heretofore. Hendricks' Register contains classified lists of the manufacturers of practically every article used in commerce and industry. The names of the various manufacturers are listed alphabetically under their proper classifications and complete street addresses are given for the larger cities.

Correct Size of Tuyeres

By W. J. Keep

Question:—Kindly advise what the tuyere area should be for a cupola lined to 30 inches inside, melting about 7,500 to 80,000 pounds per heat. Would flat or round tuyeres give better results? We do general jobbing work.

Answer:—Do not use round tuyeres unless you propose to vary their distance above the sand bottom for melting iron for small and large castings. If the tuyeres are to be stationary and are fed from a wind belt, use six 3 x 12 inches inside measurement. The bottom of the inside should slope toward the inside of the cupola so that if iron and slag should enter it will run back in the furnace again. The sides should contract toward the shell which will afford an opportunity to knock out any accumulated iron. The top should slope up toward the shell. This will give the tuyeres an area of about 6 x 6 inches where they enter the shell. You state that you would like to vary your heats from 3½ to 40 tons per day. You might melt 10 tons in a furnace of this size, but if you want to increase the heats in the future, a cupola should be secured having a shell diameter 6 feet in diameter. It is more advisable to install a small cupola and later a large furnace and run them separately for heats of varying size.

The U. S. Reduction Co., East Chicago, Ind., manufacturer of aluminum alloys, babbitt metals, solder, etc., has just completed the erection of two buildings one to be used as a warehouse and the other as a laboratory.

How to Increase Safety of Cupola Operations

Description of Devices Which Have Proved Valuable in Reducing Accidents Around the Cupola

SAFETY KINKS around cupolas are discussed and described in a recent bulletin issued by the committee on safety and sanitation, of the National Founders' Association. All of the devices illustrated are in use in one or more foundries where they have proved valuable in preventing accidental injuries and afford added comfort to the workmen. Foundry employes are exposed to the danger of tripping over or stepping into hot metal in pig molds when the latter are kept on the foundry floor.

These molds or chills also are hard to handle and are apt to accumulate moisture which will cause explosions of molten metal when it is poured into them. Open sand pig beds are a similar source of danger, especially when they are located in exposed places.

These hazards, however, may be avoided by the use of turn-over pig molds, one type of which is shown in Figs. 5 and 6. The excess or dull metal is poured into these molds and promptly dumped out in shapes that are easily handled. The molds are kept upside down when not in use to prevent workmen from splashing water into them.

A cupola screen, Fig. 1, or a similar device, offers an effective way of catching pieces of slag or brick which may be jarred from the walls of cupolas while workmen are repairing the lining. The screen is made of two half circles of heavy wire cloth securely attached to strong, round iron frames. The two halves are hinged together at the center, are free to fold downward, but are rigid when suspended from the flexible wire rope sling attached to the upper side of the screen.

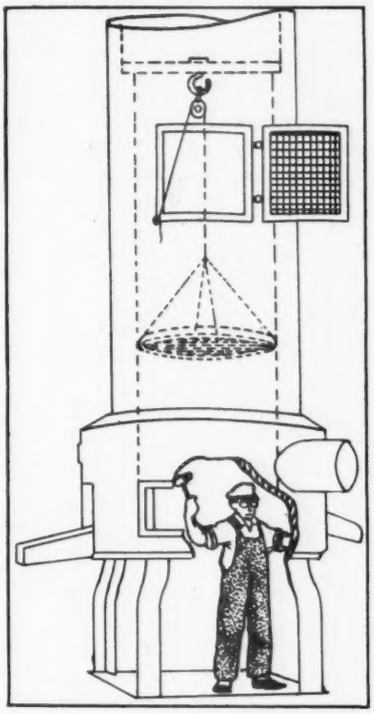


FIG. 1—CUPOLA SCREEN IN PLACE

The cupola screen can be raised or lowered, to suit the working position of the man underneath, by means of a rope rigged to a pulley block attached to a cross beam. The latter rests upon the cupola walls at the point where the single brick lining begins.

Sometimes, when several cupolas are located alongside each other, one is being charged while workmen are repairing another, in which case the men charging the cupola may, in mistake, throw into the idle cupola pig iron or other materials which the cupola screen may not be strong enough to hold. To prevent injury in such instances to cupola repairmen, it has become the practice to close and lock all the doors of cupolas not in actual service.

The value of the slag shield, Figs. 4 and 7, is obvious; it is more than a safety device, for it makes available for safe and effective use considerable floor space in the rear of cupolas which would otherwise be wasted. It also keeps the walls and ceilings comparatively free of slag cobwebs. The shield is constructed of sheet metal,

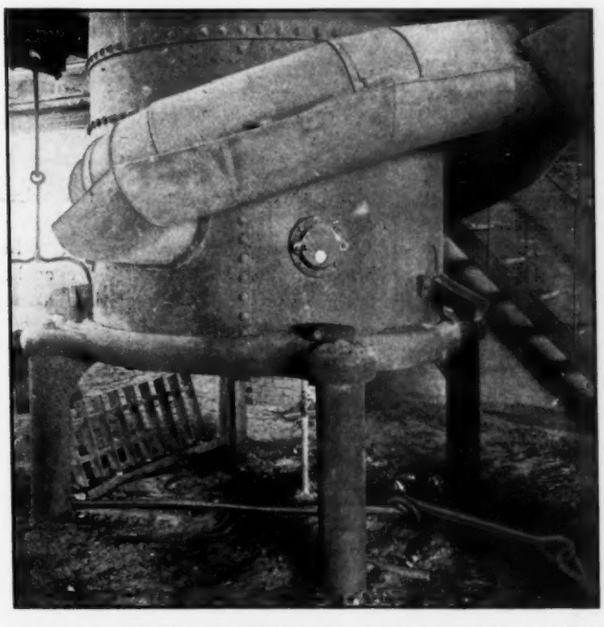


FIG. 2—RAKE IN POSITION TO CATCH REFUSE WHEN CUPOLA BOTTOM IS DROPPED

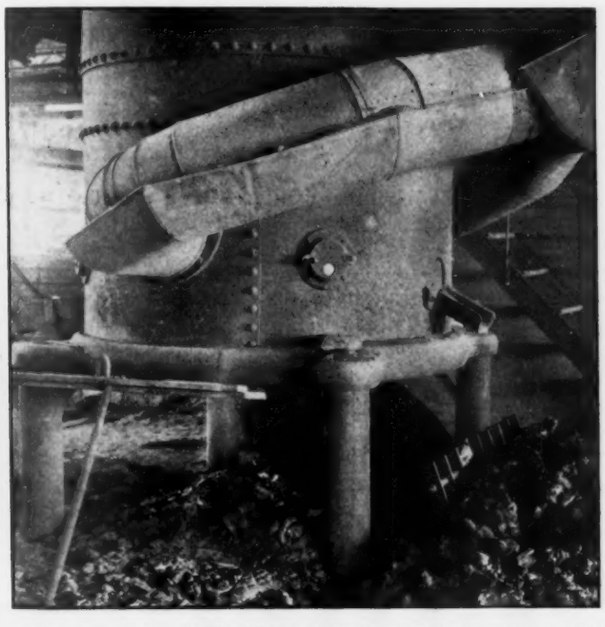


FIG. 3 — HOT REFUSE DRAGGED FROM UNDERNEATH THE CUPOLA

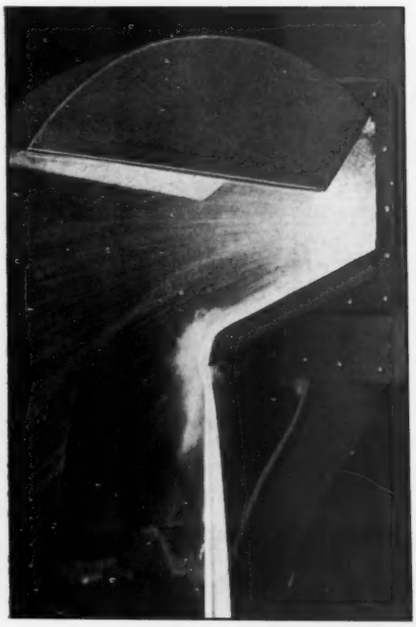


FIG. 4 — SHIELD RAISED, SHOWING SLAG UNCONTROLLED

but others now in use are made of cast iron or cast steel. It is hinged to the slag spout frame and, when required, is held in open position by a chain attached overhead, or may be held back by a hook.

The rake for the cupola drop is used in various forms in many foundries. It is placed in position before the cupola bottom doors are closed, as shown in Fig. 2. After the slag and cinders are dropped, the rake is attached to a cable, which in turn is passed around a sheave wheel anchored in the floor, and then hitched to a crane which drags the hot refuse to a point where it can be safely and easily handled. The use of the rake is illustrated in Fig. 3.

In the foundry in which the photograph was taken no crane is available. The cable, therefore, is attached in the same way to an elevator platform in the rear; the elevator is then hoisted enough to drag the rake to a clear space behind the cupola.

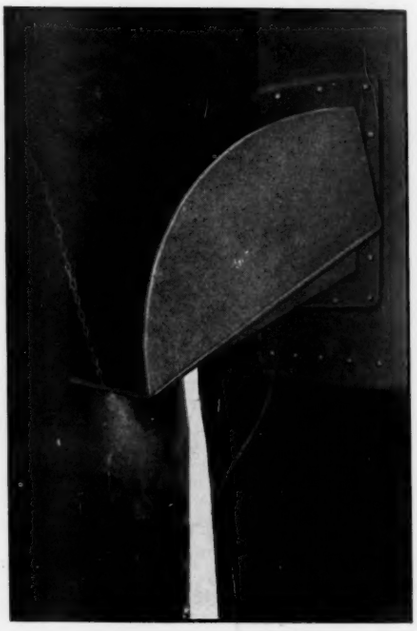


FIG. 7—SLAG CONTROLLED BY SHIELD

FIG. 5—POURING DULL METAL INTO TURN-OVER PIG MOLDS

FIG. 6—DUMPING THE PIG MOLDS

Phosphorus Limit in Malleable Castings

By Enrique Touceda

IN VIEW of the non-insertion of a phosphorus limit in the specifications for malleable iron castings, that have been lately adopted jointly, by the American Foundrymen's Association and the American Society for Testing Materials, investigations have been made by the author, the results of which, it is believed, will indicate that these associations have not erred in simplifying the standard to this extent. What has been written may prove not only of general interest to the malleable iron industry, but to those also who have closely followed up the effect of phosphorus in ferrous products.

Having spent the first 10 years of my working life in the manufacture of steel, I come honestly by a bitter prejudice against phosphorus, and while this prejudice, as far as steel is concerned, is still with me as strong if not stronger than ever, on reminiscing over past experiences and the many cases I can recall, the feeling exists that in numerous instances, mysterious failures in low carbon steel, attributed at the time wholly to a phosphorus content slightly above the bessemer limit, would have been found to have been due to faulty structural conditions, had we at that period possessed the knowledge since gained through the use of the microscope.

There is ample proof that when phosphorus is accompanied by carbon in the combined state it has a tendency to embrittle steel in some proportion with increase of carbon. Owing to the familiarity of all with this fact, many have carried their prejudice so far that they deem it unwise to take any liberties with this element, even in cases where the amount of combined carbon is inappreciable, as in wrought iron or malleable iron castings, and there are still individuals who desire to restrict the phosphorus limit in these two products to less than 0.15 per cent.

Until several years ago the writer

A paper read at the annual convention of the American Foundrymen's Association, Atlantic City, N. J., Sept. 28 to Oct. 1.

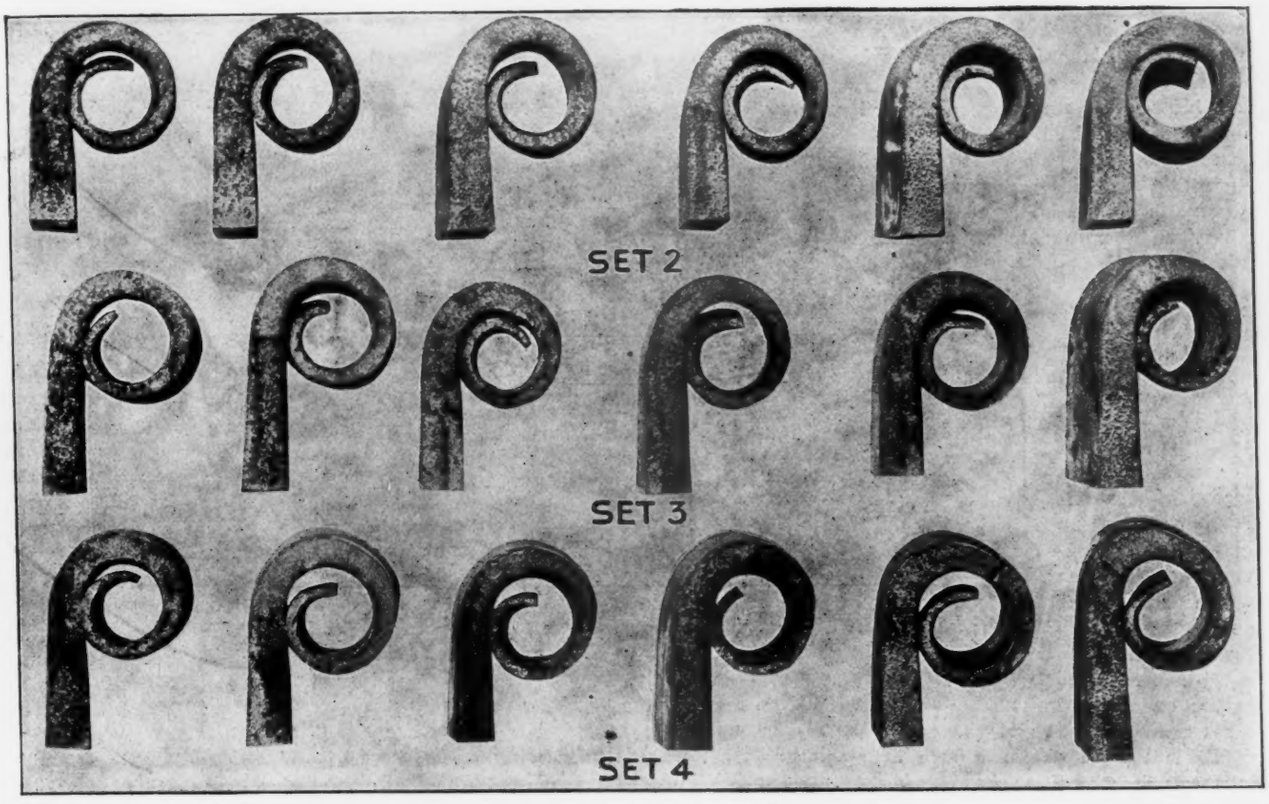


FIG. 1—TESTED WEDGES REPRESENTING SETS NOS. 2, 3 AND 4

was strongly of the opinion that no good and dependable malleable iron could be made with a phosphorus content in excess of 0.20 per cent, and this opinion had been strengthened by the examination of many poor samples that had come to hand from various sources. As time passed, however, and the true cause of failure was, through study and investigation, thoroughly understood, the fear of phosphorus grew less, and while it is not my purpose to recommend, as a general proposition, that the manufacturer of malleable iron castings should take undue liberties with this element, especially as it leads to no saving in cost—since pig iron with a phosphorus content of 0.18 per cent is as plentiful and as cheap as that containing 0.30 per cent — still there are particular cases where to use a slightly higher percentage than is customary would result in a better product. Just what is meant by this statement will be made clear a little later when we consider the data obtained from the physical tests.

For the purpose of investigating this problem as well as the time at my disposal permitted, and inasmuch as it is an acknowledged fact that the effect of phosphorus in steel is to render it more unreliable under shock than under static stress, I decided to confine my experiments to the testing of specimens dynamically, for the reason that if the metal proved good under such conditions there could be no question as to what would be shown under tensile test. The character of test specimen selected and the method of testing have been described previously in other papers, but for the benefit of those who are not familiar with these discussions, I will state that the test bar is wedge-shaped, 6 inches long by 1 inch wide throughout, the dimensions of the base being 1 x ½-inch and of the top, 1 x 1/16-inch.

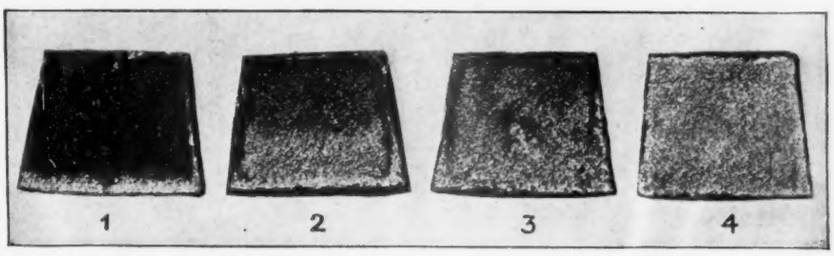


FIG. 2—FRACTURES OF FOUR MALLEABLE BARS, SHOWING RESULTS OF INCREASING PERCENTAGES OF PHOSPHORUS

To test a specimen, its base is securely keyed into a slot in a vise free to rotate in the anvil of a drop hammer. The weight then is raised and the free end of the wedge is struck repeated blows; the effect of each blow is to cause the end of the wedge to curl up until finally failure takes place by fracture. The vise and anvil block have been so constructed that the wedge, when struck, receives the full force of the blow without upsetting. To accomplish this, the vise had to be so designed that the operator can turn the wedge in such a manner that the weight is always falling on the highest part of the curled end. The tripping pin that releases the hammer is in a fixed position to deliver an initial blow of 70 foot-pounds, but a little reflection will prove that each succeeding blow is greater than this amount. This is due to the fact that owing to the curl of the wedge the weight has a slightly greater distance to fall before coming in contact with it than when the initial blow was struck, coupled with the fact that the maximum effect of the blow does not take place on the section struck, but on the extreme fibers of a section some distance from the former.

Through the courtesy of two pro-

ducers of malleable iron castings I was furnished with sets of test bars, those from Manufacturer *A* having consisted of 24 wedges. The first six of this series were cast from a ladle which contained 30 pounds of air furnace iron corresponding to the mixture that was being run in the foundry at that time. The next six were cast from the same ladle of iron, but after an addition of a certain amount of 20 per cent ferro-phosphide had been made; the next six were cast after a further addition of the alloy, and the last six after a still further addition. In this manner four sets of six wedges were obtained, the composition of which differed approximately only as to phosphorus content. At the time when the wedges were made, a ⅞-inch square bar (not exactly square owing to draft) also was cast for transverse test, and the analyses in Table I were obtained from drillings taken from these bars and not from the wedges.

Table I.
CHEMICAL ANALYSIS OF WEDGES CONTRIBUTED BY MANUFACTURER A.

	Set No. 1. Per cent.	Set No. 2. Per cent.	Set No. 3. Per cent.	Set No. 4. Per cent.
Silicon	0.800	0.810	0.800	0.800
Phosphorus	0.181	0.252	0.325	0.388
Sulphur	0.099	0.100	0.106	0.100
Manganese	0.284	0.290	0.291	0.251
Combined carbon	0.050	0.070	0.050	0.040
Graphitic carbon	2.070	1.910	1.940	2.260

Unfortunately, the six wedges belonging to Set. No. 1 inadvertently were not sent to me and I have since been unable to secure them, but inasmuch as this set was poured from straight air furnace iron without the ferro-phosphide addition, the omission will in no way affect the conclusions that can be drawn from these tests. That this statement can be made safely will be appreciated by referring to Fig. 1, which shows the curled wedges of Sets 2, 3 and 4. All of these, with two exceptions in Set No. 4, were subjected to 30 blows somewhat greater than 70 foot-pounds each. One of the exceptions broke at 28 blows and the other at 27. After the wedges shown in Fig. 1 were photographed they were again subjected to this test until failure took place, and Table II contains a record of the total number of blows required to produce fracture.

Having described the method of testing, I believe it will be acknowledged that the metal of which Set No. 4 was composed, and which contains 0.388 per cent of phosphorus, is of superior quality and is trustworthy for most purposes. The metal of Set. No. 3, which contained 0.325 per cent of phosphorus, is of still better quality and sufficiently high grade to be suitable for any purpose for which malleable iron castings may be required.

Phosphorus exists in iron as phosphide of iron. It unites with iron in definite proportion, which compound in turn is dissolved in solid solution in the excess iron. If the percentages of phosphorus in these four sets of wedges be calculated to phosphide of iron, we will obtain:

	Set No. 1. Per cent.	Set No. 2. Per cent.	Set No. 3. Per cent.	Set No. 4. Per cent.
Phosphorus	0.181	0.252	0.325	0.388
Phosphide of iron.	1.086	1.512	1.950	2.328*

*Approximate.

The ⅞-inch square bars, previously referred to, were cast at the same time and made of the same metal as the four sets of wedges, and to test these transversely, they were placed on the anvil of the same hammer, on supports 6 inches apart. The following is a record of the number of 70 foot-pound blows required to break them:

Bar No. 1. Blows.	Bar No. 2. Blows.	Bar No. 3. Blows.	Bar No. 4. Blows.
22	20	15	5

From these figures it would appear that as the section is increased, the evil effects of phosphorus become more manifest. However, bar No. 3 was subjected to fifteen 70 foot-pound blows before rupture took place, which for a metal containing 0.325 per cent of phosphorus, or about 1.95 per cent of phosphide of iron, is certainly no mean test. Bar No. 2, containing 0.252 per cent of phosphorus, or about 1.51 per cent of phosphide of iron, required 20 blows to produce failure, a test which I consider indicates superior metal. Fig. 2 shows the fractures of these four bars which indicate the changes in appearance of the fractures with increase of phosphorus.

Table II.
NUMBER OF 70 FOOT-POUND BLOWS REQUIRED TO BREAK TEST WEDGES SHOWN IN FIG. 1

Set No. 2. No. of Blows.	Set No. 3. No. of Blows.	Set No. 4. No. of Blows.
37	36	27
41	41	28
41	45	31
42	51	34
42	52	34
57	54	34
Aver. 43.33	46.50	31.33

Those familiar with the appearance of the fracture of malleable iron when tested transversely, know that the part of the bar in compression always shows up white in color for a certain distance below the surface, and with a more or less granular structure. In Fig. 2 the position of the bars is the reverse of the way in which they were tested, as the white areas represent the compression side. It will be noted that as the phosphorus increases, the amount of white area increases, and in bar No. 4 there is no difference in the appearance of the fracture on either side of the neutral axis.

In an effort to discover if the grain size had increased with the increase of phosphorus, a section was cut from each of these bars, which was polished and etched. Careful microscopical examination and a comparison of one sample with the other revealed no particular difference in grain size in any of the samples, though phosphorus is presumed to have this effect.

To avoid making conclusions from one set of tests only, samples were secured from Manufacturer *B*. The phosphorus determination of this series of wedges showed that the amount of ferro-phosphide used was not sufficient to raise the phosphorus as high as I desired for the investigation, and due to this I requested another set which contained more of the alloy.

The first set, from Manufacturer *B*, consisted of 15 wedges, three in each set, which were cast in the manner previously described. The following is a record of their phosphorus content and the number of 70 foot-pound blows required to break them:

Set No. 1. Blows.	Set No. 2. Blows.	Set No. 3. Blows.	Set No. 4. Blows.	Set No. 5. Blows.
12	8	8	9	14
10	9	8	7	6
9	9	14	10	8
		Phosphorus.		
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
0.159	0.169	0.180	0.195	0.220

I subsequently received another series of 15 test wedges and set No. 1, untreated metal, had the following analysis:

	Per cent.
Silicon	0.870
Phosphorus	0.155
Sulphur	0.052
Manganese	0.239
Combined carbon	0.040
Graphitic carbon	2.580

The number of 70 foot-pound blows required to break these five sets of test wedges and their respective phosphorus content follows:

Set No. 1. Blows.	Set No. 2. Blows.	Set No. 3. Blows.	Set No. 4. Blows.	Set No. 5. Blows.
6	7	7	6	7
7	8	8	6	4
9	6	6	7	5
		Phosphorus.		
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
0.155	0.181	0.207	0.235	0.277

It will be noted that none of these sets of wedges furnished by Manufacturer *B* contains as high a percent-

age of phosphorus as those furnished by Manufacturer *A*. The metal from which these wedges were cast was of poor quality, but the practice of this shop has since been corrected. Unfortunately, the wedges were not cast as well as they might have been, which also may account for some of the variations in the results. When a test bat is subjected to such a severe test as the one used in this instance, any surface defect on the tension side is bound to influence the result to the disadvantage of the test bar.

From a consideration of the facts before us, it would appear that when the amount of combined carbon is very low, the evil effects of phosphorus are slow to make themselves felt, and it requires a substantial increase in this element before a corresponding change in physical characteristics can be noticed.

Patterns occasionally are delivered to casting plants from which it is almost impossible to obtain satisfactory castings free from shrinkage in parts that should be very strong, in spite of the generous use of heavy risers and chills. A shrink results from failure to supply liquid metal to the mold so that as the shell of the casting gradually builds up with solid metal, liquid metal always will be present to fill up solidly the last void in the casting. There are many circumstances that operate to make difficult, or entirely prevent, complete solidity in the average casting. A discussion of these is unnecessary to make clear the point I desire to make, namely, that of two furnace mixtures, one much more fluid at the same temperature than the other; the former will produce castings from the same pattern with less shrinkage than the latter.

Not Fault of Metal

I have examined castings that have failed and have tested pieces cut from different portions of these castings to prove that these consisted of metal that was as tough and strong as malleable iron can be made, and that failure resulted because of local weaknesses due to unsoundness from shrinkage.

Unfortunately, according to present practice, the conditions that yield the toughest and strongest malleable are those that have a tendency to produce sluggish metal. Phosphorus being constant, carbon is that element in air furnace iron that contributes more fluidity than any other, but experience has demonstrated that among other accompanying conditions, the lower the carbon approaches that point where the hard carbides in the white iron can still be broken up in the anneal, the stronger and tougher the finished product.

If the facts as I have stated them are correct, then I would like to submit this question for your consideration: In castings made from patterns poorly designed and which the manufacturer is not permitted to alter, or in complicated castings made from patterns that have been designed as well as skill can suggest, is it better practice to have certain parts of the castings strong and solid, and other parts weak and unsound, or is it better to effect a compromise and have the castings of fairly uniform strength and solid throughout? There surely can be only one answer to this question. It is wrong to assume that the physical properties of a metal, as shown by tests, on test bars easily cast sound, are representative of the quality of the metal in any part of a casting.

In my opinion the manufacturers who are producing the best product are the ones who are constantly aiming to increase the strength of the weakest parts of their castings, the parts in which, due to certain laws, unsoundness is liable to occur, unless new laws are invoked to make these inoperative.

In conclusion, I will acknowledge that the experiments made are few in number, but the paper is not presented as one that has treated the subject in any other than an introductory manner. I hope that others will follow this particular line of investigation so that it can be determined definitely just how far it is safe to make use of phosphorus and to ascertain whether thickness of section is a factor entering into the problem.

How to Test Lenses of Goggles

By F W King

FEW foundrymen realize the tremendous advances made the last few years in the design and construction of goggles used to protect the eyes of chippers and other foundry operatives. A comparatively short time ago almost anything in the form of a 10-cent spectacle was considered quite proper, and only recently has the importance been realized of using lenses of ground optical glass, especially heat-treated to withstand a heavy blow. Contrary to the general belief, only a few types of goggles are provided with such lenses. Some foundries are still using masks or protectors made of wire mesh, but as a rule, they are being rapidly abolished, as the men complain that constantly looking through a screen tires their eyes and it is a fact that a screen cuts down the illumination 30 per cent and makes the vision itself, bad enough to be dangerous.

The price of a goggle no longer is the first consideration. Competition is too keen for the goggle manufacturer to charge a fancy price for them. More than 100 types of goggles are on the market, the cheapest being sold at about 75 cents a dozen, and the best, at $11 a dozen. Large quantities are sold on a sliding scale according to the number ordered. The cheaper type is worth possibly 75 cents, certainly no more. Like anything else, one receives just about what he pays for. The finest goggles are the best value to be had for the investment. Costing a little over 90 cents a pair wholesale, the same quality of goggle would retail at about $2.50. No large concern, progressive in safety work, considers anything but the best. Frequently, the loss of an eye, through the use of improper goggles, costs enough to properly equip a county with goggles, to say nothing about the humanitarian features of the case. Generally speaking, the largest manufacturers are furthest advanced in safety eye protection and on account of the great hazard involved in the employment of a large number of men they have demanded better and stronger goggles and lenses than at first could be furnished.

The United States Steel Corporation was the first to adopt a standard of required strength for lenses, and other large manufacturers have drawn up similar specifications. The Illinois Steel Co., Chicago, has designed a drop test machine for test-

Portions of a paper presented at the twentieth meeting of the American Foundrymen's Association, Atlantic City, N. J., Sept. 28-Oct. 1.

ing lenses with a steel ball, magnetically relieved from a height of 21 inches. This machine was illustrated and described in *The Iron Trade Review,* Dec. 31, 1914.

The test is made as follows: Out of every gross of goggles received, one dozen are selected at random and the lenses of 25 per cent of these must stand, without breaking, fifteen 21-inch blows of a ball weighing 16.25 grams. When the glass is broken the pieces must hang together and not splinter or fly in towards the eye. If the goggles will not pass the test, the whole shipment is refused. While some lenses would pass this test, it was agreed by manufacturers and users that stronger lenses would be desirable and as the result of a large amount of research, lenses have been developed which will withstand a much greater impact than that provided by the Illinois Steel Co.'s specifications.

The workman's compensation service bureau and the compensation inspection rating board of New York recognize the importance of the use of goggles and respirators in industries where the eyes and lungs of workmen are exposed by allowing a 1 per cent credit on the insurance rate. The clause referring to this credit in the universal analytic schedule follows:

"In all industries where necessary, and where workmen are furnished with approved types of goggles and where those engaged in dusty places are furnished with respirators, 1 per cent credit on insurance rate."

The importance of this cannot be overestimated. Realizing the cost of goggles, the recognition of the liability companies is certainly a fair one and offers financial inducement to the employers to furnish their employes with eye protectors of approved types.

In addition to the standard already outlined, the Underwriters' Laboratories have adopted specifications which form a part of this paper. The specification of the Underwriters' Laboratories only recently have been issued and they are much more rigid and exacting than those previously adopted.

It might be added that there has been considerable criticism of the drop test as not reproducing correctly the blow of a chip of steel traveling at a great velocity. A similar test of lenses is made by the use of a pendulum, and by lengthening its swing, any desired impact may be reproduced. Lenses which satisfactorily pass the drop test also pass the pendulum test.

Lenses have been developed which not only will pass the impact test of a 1-ounce ball, 5/8-inch in diameter, but will not break from the force of a blow of a 9-ounce ball, 1½ inches in diameter. The test is almost unfair, since the goggles are mounted rigidly on a hard rubber pad, whereas in actual use, when a blow is struck, there is a spring of the goggle in addition to the padding afforded by the skin and flesh of the wearer.

An outline of the new underwriters' specifications follows:

Quality of Glass.—All lenses should be of clear optical glass free from flaws (waves, air-bubbles, etc.) and ground on both sides. The lenses must not show a variation in thickness of more than 0.0040 inch. Fifty per cent of the submitted samples should be examined as outlined above.

Size. — The minimum allowable diameter of the lens on any axis is 1½ inches.

Lens Replacement. — The lenses should be so designed that replacement without injury to the frames is possible and should be distinctly marked so that no similar stock size of any inferior quality of lens may be substituted. Frames are to completely surround the lens and otherwise be so shaped that they will closely fit the face of the wearer. They shall be made of a material which is light and strong, and easily adjusted to fit the individual without danger of breakage. Joints to be secured by rivets, pins, solder or screws. Where frames are adjacent to the nose they shall be cupped, or otherwise designed, so as to form a complete guard and leave no openings at these points for the entrance of foreign materials.

Guards or Shields. — Shields should be made of light, strong, durable material which may easily be kept in a sanitary condition. They should allow a clear vision in every direction, should have rounded edges, and shaped to fit the face closely without causing discomfort, but must not be sufficiently rigid or so shaped that they may cause injury if a severe blow should drive them into the temples. If wire screen is used it should be at least 40-mesh, but not fine enough so that it is easily distorted or jammed. If perforated metal is used the holes are to be not larger than 0.02-inch in diameter and shall not interfere seriously with the clear vision of the operator. It is important that proper ventilation be provided in a manner which does not defeat the function of the goggles. The complete goggle shall not weigh in excess of 71 grams or 2½ ounces. Each lens shall bear a distinctive marking and the frame shall be marked with the name and address or trade mark of the manufacturer.

In order to obtain a representative test of the practicability and adaptability of the goggles they should be tested as follows: Six observers are each given a pair of goggles which are to be worn for a period of one hour. Each observer is to be given the size of goggle which best fits his face and the minor adjustments are to be made to secure as nearly a perfect fit as possible. At the end of the hour the observers will make a report as to their experience bearing upon the comfort of the goggles, especially at the following points: Back of ears, bridge of nose and temples.

Goggles must be subjected to boiling water or steam in order to sterilize. The following test indicates whether the samples may be expected to withstand extreme temperature changes without cracking: Goggles are to be immersed in cold water, temperature 10 degrees Cent., for 15 seconds and plunged immediately into boiling water, temperature approximately 100 degrees Cent. A failure of 10 per cent of the lenses so tested will result in the rejection of the entire lot of goggles.

Perspiration will corrode the metal portions of goggles to an objectionable degree unless they are made of materials, or provided with protective coatings, which resist corrosion. The following test is for the purpose of determining the ability of the goggle to resist corrosion: The goggle shall be immersed in a solution containing 10 per cent, by weight, of sodium chloride, for a period of 24 hours. Temperature of solution to be not less than 20 degrees Cent. nor more than 40 degrees Cent. at any time. Goggle should be removed from solution without wiping and allowed to dry for one hour. It is then to be examined for corrosion and, if found to be seriously affected, the manufacturer must show that proper protection has been provided before the goggle may be recommended for labeling.

The frames must withstand the tests outlined herewith, without taking a permanent set:

1.—*Load perpendicular to plane of lens. Eight-ounce test.*—The right lens is laid flat on a table top with nose bridge and left lens projecting beyond the edge of the table. A spring balance is connected to the outermost portion of the frame around the left lens and a force of 8 ounces (½ pound) is exerted in an upward direction. If the frame shows permanent set or distortion the goggle is rejected. If 25 per cent of the test lot fails to pass this test the lot is rejected.

2.—*Load applied in the plane of lens. Four-pound test.*—The right lens is held vertically in the hand and the lower edge of the left lens frame is pressed against the center of the pan of a balance which carries a weight of 4 pounds on the opposite pan. The pressure on the goggle frame must be exerted so that the weight is raised until the scale indicator reaches the balance position and may then be released. If the frame shows a permanent set or distortion the goggle is rejected. If 25 per cent of the test lot fails to pass this test the entire lot is rejected.

Hot Metal Test

Inasmuch as these goggles may be worn by men handling molten metal such as babbitt, etc., it is essential that they serve as safeguard against injury to the eye from this source and, therefore, must pass a test consisting of the dropping of 5 grams of molten lead, three times on each lens, from a height of 18 inches. No piece of glass shall leave the frames under these tests, or the entire lot shall be rejected.

Urges Adoption of Uniform Cost Standards

American Foundrymen's Association Committee Recommends Universal Cost Keeping System — Detailed Explanation of Approved Method

IN PRESENTING the accompanying suggestions, it is assumed that practically every casting manufacturer has a cost system of some kind. These systems vary as widely as the number of cost experts or accountants by whom they are installed and due to this lack of uniformity in systems, theories or bases from which they arrive at the costs, the chaotic condition of the foundry industry today is attributable. It is evident, therefore, that the essential feature in the elimination of existing conditions is the adoption of a uniform basis or theory which should underlie all cost systems for the computation of foundry operations. In other words the adoption of a cost system is not recommended, but rather the adoption of a uniform basis of figuring costs.

The factors or theories constituting this uniform basis follow:

1.—The commodity sold by a foundry is the labor of the molder and coremaker and not the material entering into the product.

2.—The material is more or less of a constant, varying with market conditions.

3.—Cost of production fluctuates in proportion to pounds of output per molder.

4.—Overhead charges increase or decrease according to pounds of output per molder.

What the Foundry Sells

Discussing factor No. 1, what is the merchandise or commodity sold by a foundry? In the last analysis, is it not the product or the labor of one, 10 or 100 molders? Is it not what they really produce and not what the furnace produces? Now referring to factor No. 2, material is subdivided into two classes: (*a*) Material such as pig iron, scrap, coke, gas, etc., directly chargeable to melting, and (*b*) sand, flour, molasses, emery wheels, core binders, nails, chaplets, etc., are chargeable to other departments as a direct expense. Factor No. 3 is controlled by slow-moving and rapid-moving jobs. These phrases have been coined to differentiate between small tonnage per molder and large tonnage per molder. Factor No. 4 is not a constant, but is a variable paralleling No. 3, overhead charges increasing with slow-moving jobs and decreasing with fast-moving jobs.

Harmonizing Various Methods

It is evident that competing foundries in the same locality have approximately the same costs for material, labor, production (depending upon management and equipment), sales and clerical assistance, rent, interest, taxes and insurance. But they do not follow the same method of computing or grouping the foregoing. It is not difficult to ascertain accurately the total monthly and annual costs of metals, materials, labor and overhead charges. It follows then that four fundamental requirements must be considered: Accurate payroll distribution; accurate stores accounting (material disbursements, covering only the month's actual consumption — not receipts); accurate bookkeeping, and accurate accounting of production in net tons of good castings to ascertain the proper divisor for all amounts obtained from the foregoing.

The problem of greatest difficulty is to find the proper differential of overhead costs, or rather the proper method of distributing the overhead to the various departments and patterns. It will be conceded that a different overhead is to be applied to almost each and every job and briefly stated, a fast-moving job should not bear as great an overhead as one that is slow-moving.

What is the standard basis or key for such different jobs?

This has proved a stumbling block to many foundrymen and accountants, as it is difficult to get them in agreement on this point.

Many ways in which the overhead charges are figured might be mentioned, but we wish to emphasize that we are endeavoring to recommend a system which first will appeal to the manager, superintendent or foreman, realizing that the expert accountant may criticize this recommendation in not having carried it out in further detail. To obtain the hearty co-operation of all of the heads of the departments to insure the satisfactory operation of a cost system, it should be simple and not too greatly involved. We have endeavored to find not necessarily the most perfect system, but the simplest one which can be applied most easily by the greatest number of foundrymen. Therefore, it has been decided to recommend what might be termed "the-tonnage-per-day-per-man-plan".

In recommending this plan it is realized that many will take issue with it. Some may inquire about weight and while this point is acknowledged as well taken, it is not advisable to become too scientific at the beginning, as the plan can be further refined. What is required is a simple theory to begin with, one that any manager, superintendent, foreman or molder can comprehend fully and not one that is merely understandable by an expert and an accountant. One reason for adopting what might be termed "the-tonnage-per-day-per-man-plan" is that almost every foundry can turn to its past records for a year or several years and establish an average per day per man that has been molded for this period. Also the number of molders' hours for a similar period can be ascertained. Then ascertain if the average man produces 100, 500, 1,000 pounds per day, or whatever amount this may be, and the standard of the plant thus is secured to start with. It will not be difficult to obtain the total amount of expenses or overhead charges for the same period as covered by the tonnage per man, as almost any system of bookkeeping will show this. Divide this total by the total tonnage produced during this period and the average overhead expense per ton or per pound, as well as the average production per molder, will thus be obtained.

Variable Distribution of Overhead

The overhead is based entirely on the labor of the molder and coremaker, eliminating cleaning room labor, etc., which might be included but which will not be taken into consideration at this time as cleaning costs, etc., will be taken care of subsequently.

It will be assumed that two standards have been obtained, namely, the tonnage or pounds per man and the overhead per pound. Suppose that the tonnage per molder per day, or the

From the report of the cost committee of the American Foundrymen's Association, presented at the twentieth annual meeting, Atlantic City, N. J., Sept. 28-Oct. 1, 1915.

average output per day per man, is 500 pounds and that the overhead expense per ton is $10, or ½ cent per pound. If the job is of the average molding type, one which can be produced at the average of 500 pounds the average cost applies. If, on the other hand, the job is light weight, difficult or slow to mold and only 250 pounds is obtained per day, the overhead would be about twice as much as when the output was 500 pounds, or the equivalent of $20 per ton, or 1 cent per pound in place of the standard or average of ½ cent per pound. It then is necessary to add to the average cost not only the cost of extra molding, but the ½ cent additional overhead cost. It is apparent that if the foundry is operated on this slow-moving class of work entirely, the yearly tonnage would be about one-half of the average. The expenses would be about the same and, therefore, the costs for conducting the business would be twice as much per ton as on average jobs. Unfortunately, most foundrymen fail to add the ½ cent increase for overhead, although they may be laboring under the delusion that they are adding it under the extra cost of molding.

Rapid-Moving Jobs

Let us consider another job in which the reverse condition applies. This can be molded at the rate of 1,000 pounds per day per man and the tonnage produced, therefore, will be twice the average of 500 pounds. The overhead expense per ton then will decline about one-half; let us assume that it is 50 per cent. From the average cost should be deducted the amount saved in molding and also one-half of the overhead cost, or $5 per ton. The amount chargeable for overhead will then be ¼ cent per pound instead of the standard ½ cent per pound. On this class of work the tonnage per year would be double and with the overhead expenses practically constant, it is apparent that the overhead per ton would be only one-half of the previous average overhead. In competing for business the foundryman who does not take into consideration the variables cited will not get the order and only too frequently complains that his competitor did not know his costs and obtained the work at ruinous prices. It follows then that the foundryman, without an adequate cost system, readily secures all the difficult work on which no profit can be realized, as his price is liable to be lower than his competitor on this class of work, whereas he is not favored with the better class of work or the rapid-moving jobs owing to his failure to consider the variable overhead. This condition will prevail regardless of the fact that this foundryman may be able to produce castings as economically as his competitor.

Variable and Constant Overhead

To define more clearly the results obtained by figuring on a variable overhead and a constant overhead, we will cite the following examples: It will be assumed that the overhead cost per molder, or floor, is $2 per day. Two jobs are accepted; on the one the output is 200 pounds per day and the other, 1,000 pounds per day. It will be assumed that on both jobs the molder receives $3.50 per day. The following roughly illustrates the method of estimating or calculating the costs recommended:

	Production per day, per man, 200 lbs.	Production per day, per man, 1,000 lbs.
Direct cost (molder one day at $3.50)	$3.50	$3.50
Other constant costs at 85 cents per 100 lbs.	1.70	8.50
Assumed average overhead per molder or floor	2.00	2.00
Total cost	$7.20	$14.00
Actual cost per pound	0.036	0.014

If these two tasks had been figured in the old manner of distributing costs, except direct cost for molding, we would obtain the following results:

	Castings, weight, pounds. 200	Castings, weight, pounds. 1,000
Direct cost	$3.50	$ 3.50
Average constant cost, assumed average overhead cost per pound at 1.183	2.37	11.83
Total cost	$5.87	$15.33
Assumed cost per pound	0.0293	0.0153

It will be noted, therefore, that by the recommended method of figuring the cost of 200 pounds of castings it would be 3.6 cents per pound, as compared with only 2.93 cents per pound by the old method. In other words, the slow-moving job, by the old method of figuring, would take a lower price than the slow-moving job by this method of estimating. On the contrary, the fast-moving job, involving 1,000 pounds of castings, would be charged for at a higher rate by the old method than by this plan, namely, 1.53 cents per pound, as compared with 1.4 cents per pound.

The effect of the proposed system is to load a higher cost on slow-moving jobs. It is believed that foundrymen generally have appreciated the necessity for this since it is evident that a shop which is compelled to operate on slow jobs does not turn out as many, nor does it get the returns that it would on jobs permitting a higher tonnage. It is not claimed for the foregoing system that it will prove to be 100 per cent efficient, but in most instances it will be above 75 per cent accurate, and in some lines this may exceed 90 per cent.

This report would not be complete without incorporating a recommendation for the adoption of a general form for ascertaining the annual or monthly operating cost, including the totals of the three following fundamentals: Metals consumed, material consumed, labor and salaries.

These items can be subdivided and distributed over the different foundry departments. This distribution, shown on the accompanying form, is as follows:

1.—Melting department.
2.—Molding and core department.
3.—Cleaning department.
a.—The total of these gives the producing total of metals, material and labor.
4.—Pattern department.
5.—Flask department.
6.—Power, light and heat.
7.—Repairs and maintenance.
8.—Yard.
b.—The total of the foregoing shows the entire manufacturing cost.
9.—Rent account, including insurances, taxes, obsolence or depreciation, and interest on plant account.
10.—Administrative or executive expense, including balance of interest, salaries, stationery, telephone, postage, etc.
11.—Sales department.
12.—Extraordinary charges.
c.—The total gives the general cost.
13.—Castings returned from customers.
d.—Grand total of the entire cost. The item of total dollars expended should check with the ledger.

This will give the general average cost for the tonnage produced and can be used as the cost standard if the principal differentials are added or subtracted. It also can be employed in the nature of a check on the results of each foreman from month to month or what is termed "the control or comparative cost". In the foregoing subdivisions is included the item of extraordinary charges. This is separately indicated to eliminate from the preceding departments any unusual charges which would not be constant and would otherwise affect the control cost or prove to be unreasonable charges against a certain department for the month.

Voucher System Recommended

To obtain this result the use of a voucher system is recommended. It also is essential to have an accurate payroll distribution for each department, and it is necessary to make a detailed distribution and accounting of all materials used. It is necessary to ascertain the accurate tonnage produced by weighing the castings or estimating such castings as cannot be weighed in bulk in the cleaning room on the first of each month, or any other period decided upon, and to add the increase or subtract the decrease from the month's shipments. The amount produced is used as the divisor of the amount charged to each department and also the total value charged to all departments, according

to the amounts shown by the voucher record or ledger. If this production divisor is not correct, it throws out the cost for the month and the succeeding month.

The accompanying chart is compiled on an assumed production of 500 tons per month and it will be noted that it records the amounts charged to each department and the cost per ton of material and labor and the total cost per ton for each department. While the foregoing gives the average of one month only, it is necessary to obtain averages covering periods of one, two or as many years as desired to obtain an average that will cover a period of trade depression and periods of prosperity. In the compilation of these averages practical knowledge and common sense should be employed. Remember that the metal is not the only merchandise sold and shipped. While the metal cost is fairly constant, it fluctuates somewhat as the result of the remelting of scrap, including heads, gates, risers, etc. In explaining the methods by which the average is obtained the figures on the accompanying chart will be referred to. It is essential to ascertain the average remelt, especially that of heads and gates, so that if an order takes a large head the proper differential should be added to the standard average cost of $65.30.

Production 500 Tons

		Metal		Materials		Labor		Total	
		Total	Per Ton	Total	Per Ton	Total	Per Ton	Total	Per Ton
	1. Melting	$850.00	$1.70	$1000.00	$2.00	$1300.00	$2.60	$1080.00	$21.60
	2. Molding and Cores			1375.00	2.75	(Direct 500.00 Ind. direct 250.00) 750.00	1.50	887.50	17.75
	3. Cleaning			1000.00	2.00	400.00	.80	500.00	10.00
Manufacturing Overheads	a. Producing Total	850.00	1.70	3375.00	6.75	1280.00	2.560	2467.50	49.35
	4. Pattern			150.00	.30	225.00	.45	375.00	.75
	5. Flasks			275.00	.55	100.00	.20	375.00	.75
	6. Power, Light, Heat			550.00	1.10	250.00	.50	800.00	1.60
	7. Repairs, Maintenance			265.00	.53	400.00	.80	665.00	1.33
	8. Yard			25.00	.05	400.00	.80	425.00	.85
Executive Overheads	b. Manufacturing Total	850.00	1.70	4640.00	9.28	1417.50	2.835	2731.50	54.63
	9. Rent Account			600.00	1.20				1.20
	10. Administration			1000.00	2.00	2050.00	4.10	3050.00	6.10
	11. Sales			1000.00	2.00	325.00	.65	425.00	.85
Other Overheads	12. Extraordinary Charges			400.00	.80	600.00	1.20	1000.00	2.00
	c. Total Cost	$850.00	$1.70	$6740.00	$13.48	$1717.50	$3.435	$3239.00	$64.78
	13. Returned Castings							260.00	.52
	d. Grand Total							$3265.00	$65.30

FORM FOR ASCERTAINING ANNUAL OR MONTHLY OPERATING COST

At this point it might be advisable to direct attention to the wide fluctuation in the percentage of castings shipped and the total melt in various shops and for different classes of work. This variation, while being greatest in steel casting work, also is a factor of importance in iron foundry practice. One large manufacturer operates two iron foundries, one on light and the other on heavy work. The output of the light foundry averages 5 pounds per casting, while the output of the heavy work shop averages 125 pounds. The proportion of shipments to melt of the light shop is 55 per cent, while that of the heavy shop is 70 per cent.

After having obtained the total average cost of $65.30, subtract the amount of direct or productive molders' and coremakers' labor, which is $10, leaving a total of $55.30. After ascertaining the direct or producing molding and core labor per ton for a job which is not exactly the average, namely $10 per ton, add to this the sum of $55.30. In other words, $55.30 is the starting point for all costs and possibly might be termed "zero labor" or the cost of castings exclusive of the molding expense.

Since the cleaning cost was not included in the direct or productive labor on which the overhead was based, it will be taken care of as follows: According to the accompanying chart the average cleaning cost is $8. If the casting is difficult to clean, the cost will exceed this amount and if it is below the average in cleaning expense, it will be less than the average of $8. This difference should be added to or subtracted from the average cost of $55.30. It is not difficult to ascertain for any casting whether it is more or less expensive than the average pattern to remove the heads and gates, or to judge whether it takes more or less grinding, chipping, etc., than the average. Large heads, excessive core work, etc., as a rule, mean high cleaning costs. From experience one can readily determine whether the cost should be increased or decreased as a result of abnormal or subnormal cleaning of any design.

Next, ascertain the average of the defective castings made in the foundry. Then add to or subtract from $55.30 an amount covering these defectives which may be estimated, or is shown by the records as applying to the particular pattern in question.

It may be approximately assumed that items Nos. 4 to 11 on the accompanying chart make up the overhead expenses. The cost per ton will vary more or less with the production, but the total amount charged against these departments will remain fairly constant. Therefore, the average overhead per ton is readily obtained and is shown to be $15.43, or approximately ¾ cent per pound.

To apply the first theory referred to, the following examples are cited:

If the job is strictly of an average type costing $10 for direct molding and core labor, the total cost will be $65.30. If the job is slow-moving, add to the standard average cost of $55.30 the proper amount of overhead. If the castings cost $20 for direct molding and core labor, which is double the average of $10, they carry $30 overhead, or twice the average of $15, which results in $55.30 plus molding and core labor, plus $15 extra overhead, and equals $90.30. If rapid-moving, and the castings cost only $5 for direct molding and core labor, they carry an overhead of only $7.50, or one-half of the $15 average. Therefore, to the $55.30 standard average cost we add $5 for molding and core labor, which equals $60.30 and from which we subtract $7.50 for reduced overhead, and we arrive at a total cost of $52.80.

In this connection, it is interesting to direct attention to the wide fluctuations in the cost of fast and slow-moving as compared with the average job. The average job in this case is represented by $65.30; the fast-moving job at $52.80 and the slow-moving job at $90.30.

The proper variations can be figured for every $1 per ton above or below the average molding and core labor cost of $10. For all practical purposes a variation of $2.50 per ton, or ⅛ cent per pound, will be sufficient. The result of the cost obtained on any particular pattern will not vary widely from that secured by a more elaborate system which is difficult to understand and frequently so burdensome that it will not receive the hearty co-operation and support of the heads of the operating department.

From the foregoing examples the following simple instructions will aid

in arriving at the proper costs. On the accompanying chart the grand total is given as $65.30.

Add or subtract for heads and gates, above or below the average or standard.

Add or subtract the difference between the specific and the standard direct molding and core labor cost.

Add or subtract the difference between the specific and the standard or average cleaning cost.

Add or subtract the difference between the specific and the standard, or average defectives.

Add or subtract the proper differential of overhead costs.

Add contingencies, extra flasks, pattern changes, etc.

By following these instructions the total cost of a casting of any pattern can be obtained.

Most foundries do not hesitate to pay good salaries to the heads of their various operating departments, but they hesitate at a proportionate outlay for an intelligent accountant, estimator or clerk, however he may be designated. It also is unfortunate that foundrymen only boast of tonnage records and rarely refer to their best months by profits regardless of the tonnage produced.

In carrying out this system, it is by no means necessary to obtain costs on all small orders, job lots, etc. However, large orders can easily be estimated, followed through the shop and checked and can be properly priced as a basis for an estimate for the next inquiry. This record of any past production also will give the number of castings made per day. Another feature of this method is that today it can be applied on any order made months ago, provided the number of castings molded per day, as well as the weight of such castings, has been recorded.

It is not necessary to tabulate the cost of every order, which will save considerable detail work, but the cost today, tomorrow or a year hence can be obtained if the records are filed indicating the output of each molder per day on the various patterns. In conclusion, it will be noted that the percentage theory has not been used for figuring the overhead, but rather the amount in dollars and cents, in the belief that this can be followed more satisfactorily by the heads of the operating departments without losing the support of the accountant.

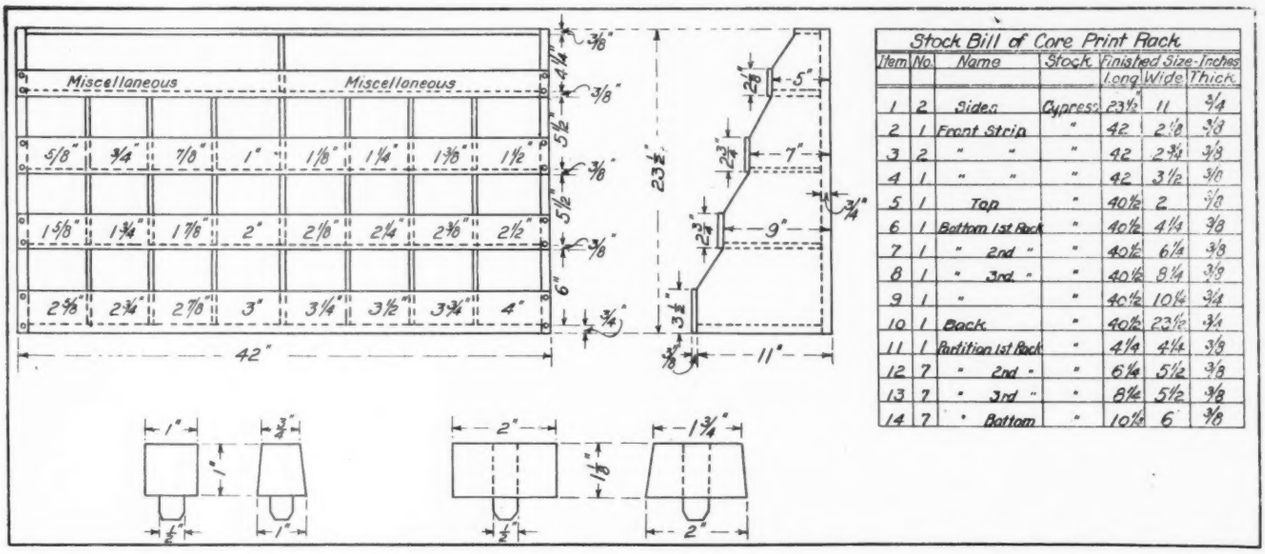
In line with the foregoing theory, the profit should be figured in dollars per ton. Let it be assumed that the justified profit is $2 on an average tonnage per month of 100, or a total of $200. If the work going through the shop is slow-moving, notwithstanding the fact that every molder is employed when only 50 tons are produced the profit should be $4 per ton, which equals the average of $200 per month. If, on the other hand, the work going through the shop is of the rapid-moving variety, so that the same number of molders produce twice the output of 200 tons, the profit could be reduced to $1 and yet make the average of $200 per month. The results by this method of computation are the same regardless of the class of work taken by the sales department.

The Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., has prepared plans for a 2-story brick and steel addition, 75 x 150 feet.

Foundry Core Print Rack

By W. H. Parry Jr.

To conveniently keep core prints together in a foundry so that they may be obtained by the molders without delay, the rack shown in the accompanying illustration has been designed and is in use in a large plant in the central west. Each compartment has a capacity for one dozen straight prints and one dozen tapered prints with the exception of the compartments for the 3¼, 3½, 3¾ and 4-inch prints, which hold six of each size. The rack can be shellaced yellow and the numbers stamped on, or it may be shellaced black and the numbers painted on in white. The dowels are turned on the prints from ⅝ to 1⅞-inch sizes. Dowels are placed separately on the 2 to 4-inch prints. All prints should have the sizes stamped on the ends. While this rack was designed primarily for foundry use, it can be applied conveniently to all departments for holding nails, screws, etc. A stock bill for the core print rack also is shown, which gives the various pieces and sizes of lumber required.



Stock Bill of Core Print Rack

Item	No.	Name	Stock	Finished Size-Inches Long	Wide	Thick.
1	2	Sides	Cypress	23½	11	¾
2	1	Front Strip	"	42	2⅛	⅜
3	2	" "	"	42	2¾	⅜
4	1	" "	"	42	3½	⅜
5	1	Top	"	40½	2	⅜
6	1	Bottom 1st Rack	"	40½	4¼	⅜
7	1	" 2nd "	"	40½	6¼	⅜
8	1	" 3rd "	"	40½	8¼	⅜
9	1	"	"	40½	10¼	⅜
10	1	Back	"	40½	23½	¾
11	1	Partition 1st Rack	"	4¼	4¼	⅜
12	7	" 2nd "	"	6¼	5½	⅜
13	7	" 3rd "	"	8¼	5½	⅜
14	7	" Bottom	"	10⅛	6	⅜

FOUNDRY RACK FOR CORE PRINTS AND STOCK BILL OF LUMBER FOR CONSTRUCTING THE RACK

Electric Furnace in Operation

The electric steel melting furnace installed at the plant of the Niagara Electric Steel Corporation, North Tonawanda, N. Y., by the Snyder Electric Furnace Co., Chicago, has been in operation for some time and has been turned over to the purchasers. The Snyder Furnace company designs, builds, installs and starts its furnaces, turning them over to the purchaser in operating condition under a fixed and definite guarantee.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

OUTSIDE DIAMETERS FOR POLYGONS

By S. L. Cook

In laying out and making patterns many cases occur where squares, hexagons or octagons must be scribed. The first step in this operation is to lay out a circle of proper diameter inside of which the polygon may be constructed. The accompanying tables give the proper diameters for these circles for polygons ranging from 1-16 to 6 inches across flats.

Distance across flats, inches.	Dia. for squares, inches.	Dia. for hexagons, inches.	Dia. for octagons, inches.	Distance across flats, inches.	Dia. for squares, inches.	Dia. for hexagons, inches.	Dia. for octagons, inches.
1/16	3/32	1/16	1/16	1 1/4	1 13/32	1 5/16	1 11/32
1/8	1/8	1/8	1/8	1 5/16	1 17/32	1 11/32	1 13/32
3/16	3/16	3/32	3/16	1 3/8	1 25/32	1 15/32	1 17/32
1/4	9/32	1/8	1/4	1 7/16	2 3/32	1 19/32	1 21/32
5/16	5/16	5/32	5/16	1 1/2	2 1/16	1 23/32	1 25/32
3/8	13/32	3/16	3/8	1 5/8	2 13/32	1 27/32	1 29/32
7/16	15/32	7/32	7/16	1 3/4	2 15/32	2 1/32	2 1/32
1/2	17/32	1/4	1/2	1 7/8	2 17/32	2 5/32	2 5/32
9/16	19/32	9/32	9/16	1 15/16	2 19/32	2 7/32	2 9/32
5/8	21/32	5/16	5/8	2	2 21/32	2 5/16	2 13/32
11/16	23/32	11/32	11/16	2 1/16	2 23/32	2 3/8	2 17/32
3/4	1 1/16	3/8	3/4	2 1/8	2 25/32	2 15/32	2 21/32
13/16	1 3/32	13/32	13/16	2 3/16	2 27/32	2 17/32	2 25/32
7/8	1 5/32	7/16	7/8	2 1/4	2 29/32	2 19/32	2 29/32
15/16	1 7/32	15/32	15/16	2 5/16	3 1/32	2 21/32	3 1/32
1	1 9/32	1/2	1	2 3/8	3 3/32	2 23/32	3 5/32
1 1/16	1 11/32	1 1/32	1 1/16	2 7/16	3 5/32	2 25/32	3 9/32
1 1/8	1 13/32	1 3/32	1 1/8	2 1/2	3 7/32	2 27/32	3 13/32
1 3/16	1 15/32	1 5/32	1 3/16	2 9/16	3 9/32	2 29/32	3 17/32

(*Continued on Data Sheet No.* 198.)

OUTSIDE DIAMETERS FOR POLYGONS

By S. L. Cook.

(*Continued from Data Sheet No.* 197.)

Distance across flats, inches.	Dia. for squares, inches.	Dia. for hexagons, inches.	Dia. for octagons, inches.	Distance across flats, inches.	Dia. for squares, inches.	Dia. for hexagons, inches.	Dia. for octagons, inches.
2 1/16	3 3/32	2 1/16	2 11/32	4 1/4	6 1/32	4 3/32	4 13/32
2 1/8	3 7/32	2 3/32	2 13/32	4 5/16	6 3/32	4 7/32	4 17/32
2 3/16	3 5/16	2 7/32	2 15/32	4 3/8	6 5/32	4 11/32	4 21/32
2 1/4	3 13/32	3 1/32	2 17/32	4 7/16	6 7/32	5 1/32	4 25/32
2 5/16	3 15/32	3 3/32	2 19/32	4 1/2	6 9/32	5 3/32	4 7/8
2 3/8	3 17/32	3 5/32	2 21/32	4 9/16	6 11/32	5 5/32	4 15/16
2 7/16	3 19/32	3 7/32	2 23/32	4 5/8	6 13/32	5 7/32	5 1/32
2 1/2	3 21/32	3 1/4	2 25/32	4 11/16	6 15/32	5 9/32	5 3/32
2 9/16	3 23/32	3 9/32	2 27/32	4 3/4	6 17/32	5 11/32	5 5/32
2 5/8	3 25/32	3 11/32	2 29/32	4 13/16	6 19/32	5 13/32	5 7/32
2 11/16	3 27/32	3 13/32	3 1/32	4 7/8	6 21/32	5 15/32	5 9/32
2 3/4	3 29/32	3 15/32	3 3/32	4 15/16	6 23/32	5 17/32	5 11/32
2 13/16	4 1/32	3 17/32	3 5/32	5	6 25/32	5 19/32	5 13/32
2 7/8	4 3/32	3 19/32	3 7/32	5 1/16	6 27/32	5 21/32	5 15/32
2 15/16	4 5/32	3 21/32	3 9/32	5 1/8	6 29/32	5 23/32	5 17/32
3	4 1/4	3 23/32	3 11/32	5 3/16	7 1/32	5 25/32	5 19/32
3 1/16	4 7/32	3 25/32	3 13/32	5 1/4	7 3/32	5 27/32	5 21/32
3 1/8	4 9/32	3 27/32	3 15/32	5 5/16	7 5/32	5 29/32	5 23/32
3 3/16	4 11/32	3 29/32	3 17/32	5 3/8	7 7/32	6 1/32	5 25/32
3 1/4	4 13/32	4 1/32	3 19/32	5 7/16	7 9/32	6 3/32	5 27/32
3 5/16	4 15/32	4 3/32	3 21/32	5 1/2	7 11/32	6 5/32	5 29/32
3 3/8	4 17/32	4 5/32	3 23/32	5 9/16	7 13/32	6 7/32	6 1/32
3 7/16	4 19/32	4 7/32	3 25/32	5 5/8	7 15/32	6 9/32	6 3/32
3 1/2	4 21/32	4 9/32	3 27/32	5 11/16	7 17/32	6 11/32	6 5/32
3 9/16	4 23/32	4 11/32	3 29/32	5 3/4	7 19/32	6 13/32	6 7/32
3 5/8	4 25/32	4 13/32	4 1/32	5 13/16	7 21/32	6 15/32	6 9/32
3 11/16	4 27/32	4 15/32	4 3/32	5 7/8	7 23/32	6 17/32	6 11/32
3 3/4	4 29/32	4 17/32	4 5/32	5 15/16	7 25/32	6 19/32	6 13/32
3 13/16	5 1/32	4 19/32	4 7/32	6	7 27/32	6 21/32	6 15/32
3 7/8	5 3/32	4 21/32	4 9/32				
3 15/16	5 5/32	4 23/32	4 11/32				
4	5 7/32	4 25/32	4 13/32				
4 1/16	5 1/4	4 13/16	4 27/32				
4 1/8	5 9/32	4 29/32	4 15/32				
4 3/16	5 11/32	4 31/32	4 17/32				

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE BRASS FOUNDRY

Finding Blowholes With the X-Rays

By C H Tonamy

THOUGH various methods of testing metals have been used for some considerable time, such as chemical analysis, metallography, and mechanical and physical testing, no method, as far as the author is aware, has been evolved until recently, for detecting internal blowholes by external examinations. Such defects usually being discovered only when the material is subjected to machining, the application of X-rays for this purpose seems likely to be of great service. Particularly is this the case with copper castings, since pure copper, when at a high temperature, absorbs gases from the air, thereby rendering likely the formation of blowholes. When making these castings a small quantity of phosphorus, tin, or zinc is usually added as a deoxidizer. Blowholes, however, are always to be guarded against, and in order to study their occurence the author made some X-ray experiments upon a thin casting of pure copper, using a Gundelach X-ray tube. The specimen which was used in the experiment was a plate of pure copper, cast at a high temperature. The plate measured 5 x 4½ inches by ¼-inch, with a hole ⅛-inch diameter and 4½ inches deep drilled in one side, as shown in Fig. 2. A channel ⅛-inch deep was planed on the surface, in order to vary the thickness of the plate. The apparatus used in obtaining the radiograph of the blowholes, drilled hole, and channel is shown in Fig. 4. The specimen was laid on the X-ray plate vertically under the Gundelach tube. By varying the vertical distance, *B*, between the center of the tube and the X-ray plate, and also by varying the time of exposure and the strength of current, the results

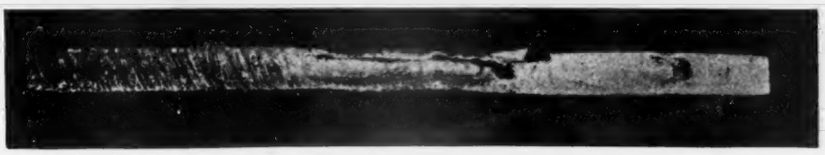


FIG. 1—SIDE VIEW OF SAMPLE CUT BY METAL SAW ALONG LINE INDICATED IN FIG. 2, SHOWING THE LARGE FLAW

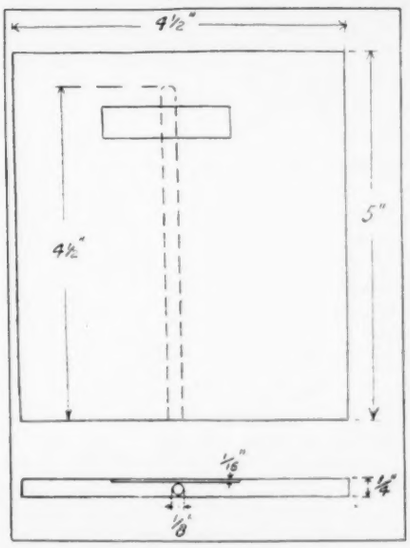


FIG. 2—SAMPLE OF PURE COPPER CASTING FOR X-RAY EXAMINATION

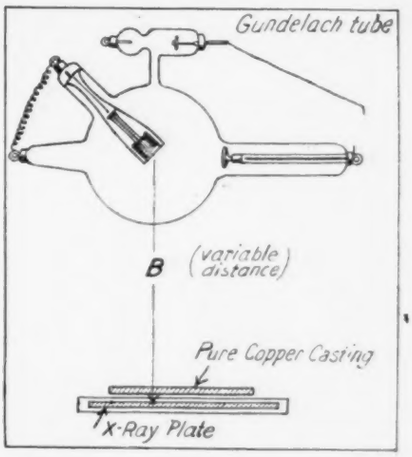


FIG. 4—ARRANGEMENT OF X-RAY TUBE, SAMPLE AND PHOTOGRAPHIC PLATE FOR EXAMINATION

FIG. 3—RADIOGRAPHS OF COPPER CASTINGS, SHOWING BLOWHOLES

The first radiograph was taken with an exposure of two minutes and five seconds, and a current of 0.8 milliampere, at a distance of 50 centimeters. The second shows the sample, radiographed with an exposure of two minutes and 30 seconds duration and a similar current, at a distance of 30 centimeters. The third is the result of an exposure of five minutes with a 2-milliampere current, at a distance of 15 centimeters.

A paper read at the September meeting of the British Institute of Metals. The author is engineer, Missubishi Dockyard & Engineering Works, Kobe, Japan.

given in the accompanying table were obtained. In order to verify the results obtained, the plate was sawed across through the indicated positions of the blowholes, and these were found to be continuous, as shown in Fig. 1. In this experiment an X-ray source of ordinary strength was used, but had there been employed a much more powerful source, the radiographs would certainly have been sufficiently distinct to determine the exact position of the blowholes. Moreover, by taking radiographs in two directions at right angles to one another, the depth of the blowholes beneath the surface of the plate could be determined. In conclusion, there is little doubt that useless work in the machine shop might be saved by testing metals by means of X-rays as described above.

No. of Experiment	Vertical Distance Centimeters	Time of Exposure Min.	Time of Exposure Sec.	Strength of Current Milliamperes	Remarks
1	50	2	5	0.8	Very faint spots obtained, which indicated the positions of blowholes.
2	30	2	30	0.8	More distinct spots obtained.
3	15	5	0	2.0	Much more distinct spots obtained together with the radiograph of the hole in the sample.

Die Casting Aluminum Commercially

By Charles Pack

THE past year, with its unparalleled conditions, has forced the die casting industry to fight for existence. None of the die casting alloys in general use exceeds cast iron in tensile strength. It can, therefore, be seen that the foundation of the die casting industry must be based on economy. The cost of any die casting must be less than the combined cost of producing that casting in iron and of machining it to a finished product, equivalent to a die casting. It will be readily seen that the cost of metal is a vital factor to the life of the die casting industry, since prohibitive prices for raw materials would exclude die casting from competition with other methods of production. The zinc market may serve as a good illustration. Approximately 85 per cent of the die castings produced in 1914 were made from zinc alloys consisting of a minimum of 85 per cent zinc, the other elements being tin and copper, which, having a higher market value, would tend to raise the net cost of the average zinc die casting alloy to approximately 5c per pound above the market price of zinc. For example, with zinc at 7c, copper at 16c, and tin at 40c, which prices are about the average, the cost of the average die casting alloy is 12c per pound. This means that in order to compete with sand casting, the die casting process must show a minimum saving of about 9c per pound on the machining cost of the casting, since the cost of cast iron does not exceed 3c per pound. The cost of intermediate brand zinc on June 1, 1915, was 28c per pound, which would bring the cost of the average die casting alloy to 31c per pound. What this high metal cost means to the die casting industry can readily be understood by considering that in order to compete, a three-pound die casting must show a net saving on its machining cost, of at least 84c. Although there are numerous instances where die castings show a saving, even at this high market, the growth of the industry must of necessity be curtailed if such conditions are to prevail, unless a substitute for zinc is to be found. A careful study of the properties of the common metallic elements reveals aluminum as the hope of the die casting industry. The normal price of aluminum before the war was 8c, which, considering its specific gravity, makes it the cheapest non-ferrous metal obtainable.

At present it is over 50c, but even at such a figure it is not surprising that die casting manufacturers should make a desperate attempt to produce aluminum die castings commercially.

Many False Claims

It has been claimed at various times that aluminum die castings were being produced in France and Germany. The writer personally investigated the claims of one individual who had just come from France, where he had discovered the "secret process" for die casting such parts as automobile crank cases, transmission gears and, in fact, any part from the size of a pin to the size of a large writing desk. This claim, as well as many others, was discovered to be without foundation; and the writer has generally found that the term "die casting" was misconstrued. The practice of inserting iron parts in a sand mold at certain points, to save machining, is not new; but it by no means constitutes die casting, by which is understood to be the process of pouring molten metal, under pressure, into a permanent *metallic mold* producing castings requiring little or no machining before assembling. That die casting is an individual industry, which was originated in this country, is proved by the fact that licenses under a process, patented by H. H. Doehler, were sold in England, Germany, Austria-Hungary, France and Canada. The writer, after a careful investigation of the subject, including the inspection of many samples of so-called aluminum die castings, does not hesitate to say that the commercial aluminum die casting is an American achievement. The Doehler process has been in operation for more than two years, during which time castings have been turned out for use on many of the high-priced automobiles and other machines. At the present time about 150,000 pounds of aluminum is being converted into die castings each month. The spark lever, throttle lever, spark and throttle sector on many automobiles are aluminum die cast by this process.

The alloy used in this process is strictly aluminum-copper, which does not contain any tin, zinc or cadmium. While on the subject of aluminum alloys for die castings, the writer would like to point out a peculiar experience, which will be of particular interest to those called upon to investigate metallurgical problems. In the course of experimenting upon aluminum alloys, about four years ago, the writer compounded an alloy consisting of equal parts of zinc and aluminum. The finest grade of zinc obtainable was used for this experiment, as well as primary domestic aluminum. The alloy was poured into ingot molds, 2 inches

A paper read at the September meeting of the Institute of Metals, Atlantic City, N. J.

wide, 1½ inches thick and 10 inches long. In the course of about two years the ingot began to crack and warp. Upon further exposure the cracks penetrated through the entire thickness of the ingot in a most peculiar manner.

A short time ago the writer's attention was called to what was supposed to be an aluminum die casting. The part had undoubtedly been die cast, but the alloy appeared entirely too dark and heavy for aluminum. Having decided to analyze the sample, the writer took some filings from it, placed them in a beaker and added a little distilled water preparatory to the addition of the solvent acids. The writer was impressed with the violence of the reaction formed by the mere addition of pure distilled water, which reaction was very similar to that obtained by the addition of weak acids to commercial zinc. Upon boiling with pure distilled water more than three-fourths of the alloy was dissolved and only a black powder remained at the bottom of the beaker, showing that the alloy was entirely decomposed by distilled water. Analysis showed the alloy to consist of an approximate even mixture of zinc and aluminum with the usual impurities of lead, iron and silicon. From the foregoing it may readily be seen that when specifying aluminum die castings, it is also important to specify that they be made from a standard aluminum-copper alloy. The purchaser should carefully guard against any untried mixtures which had been devised to meet competition and which are in most cases the result of mere chance mixing rather than of trained metallurgical investigation.

Die casting machines are constructed in two types, air machines and plunger machines. For die casting the higher fusing point metals, such as aluminum and its alloys, the plunger machine is not wholly satisfactory because of the expansion of the cast iron of which the cylinder and plunger are made. The Doehler aluminum process utilizes the air machine, the metal being forced into permanent metallic molds, under an extremely high pressure.

Aluminum die casting, although a practical commercial proposition, cannot economically replace the zinc alloy die casting where the latter is satisfactory, despite the lower cost of the aluminum alloy for the same bulk. The cause for this, which is, in fact, the most serious drawback to the expansion of the industry, lies in the life of the dies. A die for zinc alloys will last almost indefinitely, whereas with aluminum alloys, the best die material obtainable today will not produce over 5,000 castings without "heat checking". It will readily be seen that the cost of the work will be greatly increased if it is necessary that a new die be made for every 5,000 castings.

Need of Standard Railroad Car-Bearing Alloy

By Russell R Clarke

FEW PROBLEMS contain more interesting possibilities than those connected with the standardization of alloys for certain definite purposes. In the past few years the growth in a number of alloys differing only slightly from one another has been amazing, and at the present time few brass foundries escape the inconvenience of being obliged to handle from four to a dozen different mixtures on jobs that are practically identical. An examination of 20 different alloys made for the same service showed the following average composition: Copper, 84.5 per cent; tin, 5.2 per cent; lead, 4.7 per cent; and zinc, 5.6 per cent. The alloy showing the maximum variation from the average contained the following constituents: Copper, 87.0 per cent; tin, 5.0 per cent; lead, 3.0 per cent; and zinc, 5.0 per cent. In another case four closely similar alloys showed the following composition, upon analysis: Alloy No. 1, copper, 84.0 per cent; tin, 5.0 per cent; zinc, 6.0 per cent and lead, 5.0 per cent: Alloy No. 2, copper, 84.0 per cent; tin, 4.0 per cent; zinc, 6.0 per cent; and lead, 6.0 per cent: Alloy No. 3, copper, 85.0 per cent; tin, 5.0 per cent; zinc, 5.0 per cent; and lead, 5.0 per cent: Alloy No. 4, copper, 85.0 per cent; tin, 6.0 per cent; zinc, 5.0 per cent; and lead, 4.0 per cent. A study of these formulas suggests the idea that an effort was made on the part of the metal mixer to find out how many combinations can be realized from the same set of figures.

The author of this paper is of the opinion that this endless succession of minor variations is unnecessary. It is realized that a slight variation in the constituency of an alloy will often have a profound effect upon its qualities, nevertheless it is believed that variations such as those mentioned in the preceding paragraph serve no very useful purpose and that it would be better to substitute a few standard mixtures which could be made to cover practically all cases satisfactorily.

Standardization Desirable

Such a standardization of non-ferrous alloys, particularly railroad car bearing metal, would be of great assistance to the foundryman and would tend toward greater uniformity in both the price and the quality of the material.

Foundrymen realize this situation but contend that they are unable to remedy the situation owing to the fact that they are compelled to prepare their mixtures according to the specifications of their customers. It is suggested, therefore, that the preparation of standard specifications for railroad car bearing and other standard non-ferrous alloys, be taken up by such nationally recognized bodies as the American Institute of Metals and the American Society for Testing Materials.

The general adoption of standard alloys would also have a very beneficial influence on the scrap situation. At the present time, many brass foundrymen are obliged to use scrap, the composition of which is more or less indeterminate, giving unsatisfactory results on remelting. Data prepared by the U. S. geological survey shows that during 1914, 127,882 tons of secondary copper, 61,062 tons of secondary lead, 71,642 tons of secondary zinc, and 12,447 tons of secondary tin were reclaimed. A large proportion of this reclaimed scrap included discarded and worn out railroad car journal brasses. The composition of these brasses varied widely, practically every railroad having its own formula, and the difficulties in the way of reclamation were correspondingly increased. The uncertainty surrounding the composition of the brasses also handicapped the railroads in selling their car bearing scrap.

It is believed that the establishment of standard specifications should result from the co-operative efforts of railroad officials, brass founders and dealers in waste non-ferrous metals. The advice of chemists and metallurgists also should be sought and the alloy finally selected should have practical wearing qualities to recommend it. At this point it might be well to recapitulate the advantages which would accrue from the establishment of a standard specification.

From a paper presented at the Atlantic City meeting of the American Institute of Metals, Sept. 28 to Oct. 1, 1915. The author, Russell R. Clarke, is associated with the Pennsylvania railroad, Pittsburgh.

Such a specification would afford a definite knowledge of the composition of the returned scrap regardless of the source of such old material. This would permit the conversion of this scrap, without loss of time or expense, into alloys of various compositions, thus affording a ready outlet for accumulated supplies of worn out car journal brasses. It would eliminate the expense attendant upon the reduction of great quantities of scrap for the sole purpose of eliminating certain ingredients. It would enable the railroads to obtain a satisfactory alloy at a consistent price and would permit the sale of scrap material upon a basis of quality. It would reduce the number of defective castings and failures due to the presence of unknown constituents in the alloy.

Details of Journal Brasses

The modern railroad journal bearing is a casting varying in size, weight and form according to the car on which it is used. The bearings also vary according to the ideas of different designers regarding the most efficient form and dimensions for the service involved. The Master Car Builders Association, however, is now making an active effort to standardize the form and critical points of measurement of car journal brasses as completely as possible. Most of the brasses in use today are for journals of the following seven different sizes: 4¼ x 8 inches; 4¼ x 8½ inches; 5 x 9 inches; 5½ x 9 inches; 5½ x 10 inches; 5½ x 11 inches and 6 x 11 inches. These brasses weigh 11, 14, 17, 19, 24 and 32 pounds respectively. In addition, odd sizes of brasses are required for old cars which are fast disappearing from service. Among these are journals 3¾ x 7 inches, 3½ x 7 inches, 4 x 7 inches and 4 x 8 inches.

In construction, the modern car journal bearing is a composite creation embodying a solid back of copper-base metal to which a white metal lining of lead-base is attached. In bearings of the lined type, the lining is sweated on by first tinning the surface of the bearing and then pouring the filling metal into the opening between this tin surface and a mandrel against which the bearing is held. In bearings of the filled type, the white metal is retained in place by means of dovetailed pockets cast in the copper-base back of the brass. Although every bearing consists of a lead-base lining with a stiff copper-base back, both parts should have anti-friction qualities inasmuch as the lining may be worn completely through, bringing the copper back into contact with the journal.

The proposed standard bearing alloy should be cheap owing to the tremendous consumption of railroad car journal bearings. The metal must be ductile but at the same time resist compression owing to the enormous loads which it is required to carry. The metal should be comparatively free from oxide. Oxides have a detrimental influence on the proper tinning of surfaces, making it difficult to obtain the requisite adhesion between the lining metal and the copper-base back of the bearing. The metal should have a simple composition so that it can be easily prepared and handled in any brass foundry. It is now possible to consider the composition of the proposed standard bearing in detail.

Phosphor-bronze containing 79 per cent copper, 10 per cent tin, 10 per cent lead and 1 per cent phosphorus is not an ideal product for this purpose. In the first place, it is too high priced and also is more or less lacking in stability. The author believes that few non-ferrous alloys are more brittle in a heated condition than phosphor-bronze. It should be borne in mind that the conditions under which a car bearing operates are entirely different from those surrounding an engine bearing. The latter receives much more care and attention. The author also believes an alloy containing an excess of zinc would not be satisfactory because of its adhesive and heating qualities; moreover, the questionable deoxidizing capacity of this alloy renders it undesirable. Unusual or out-of-the-ordinary mixtures cannot be considered, such as aluminum-bronze, manganese-bronze, etc., for obvious reasons. Furthermore, an excessive high lead mix is not satisfactory, owing to difficulties with oxidation and changes in the quality of the metal during melting. Moreover it is difficult to finish high lead bearings satisfactorily. Buffing wheels fill up with lead and only perfectly sharpened tools and ideal conditions insure clean cuts in boring. In inspecting a solid or lined bearing, the inspector taps the brass with a hammer and judges the adhesion between the back and the lining by the ring of the bearing. The ring of a high lead alloy is dead, often misleading the inspector and leading to the rejection of good bearings and *vice versa*. The author also believes it is difficult to insure a homogeneous mixture when handling a high lead alloy. Bearings cast at the beginning of a heat necessarily differ in lead content from those cast at the end of the same heat.

The foregoing narrows the discussion down to a single practical possibility, namely a conservatively leaded bronze. The alloy which is recommended has been found to have the following basic composition: copper, 78.0 per cent; tin, 7.0 per cent; lead, 15.0 per cent. Those who have worked with this mixture are familiar with its casting efficiency and as a deoxidizing agent phosphorus is preferred, ranging from 0.25 to 1.0 per cent.

In order to obtain the opinions of representative railroad officials regarding the establishment of standard bearing metal specifications, letters were addressed to 70 large systems embodying the following inquiries:

1.—In the manufacture of car journal bearing backs, do you resort to a junk mix or one of definite composition?

2.—If definite composition is employed, can you confidentially state its formula or specifications?

3.—Do you adhere closely to this formula?

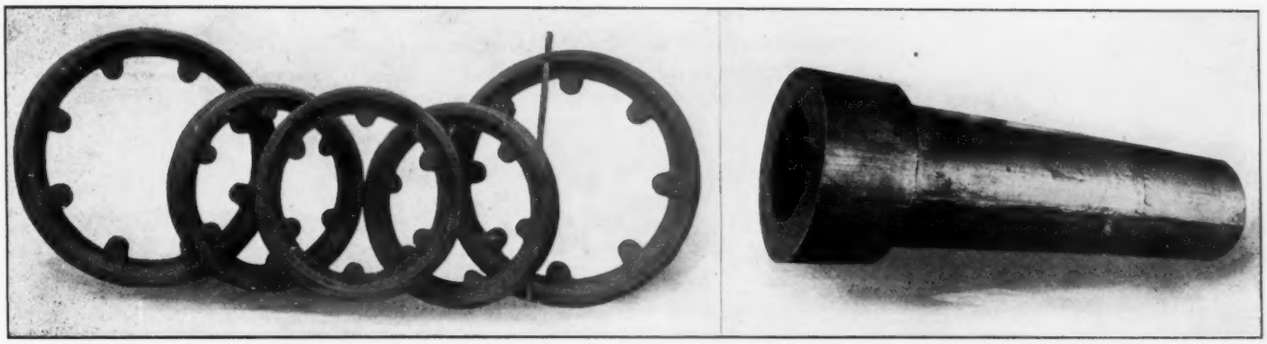
4.—Do you think a standard car bearing alloy among all railroads would be a good thing?

5.—Do you object to the use of your formula in connection with your company's name? Without it?

Opinions Favor a Standard Alloy

In general the opinions expressed in the replies received, favored the establishment of a standardized product, although in many instances the agreement was conditional. For instance, one writer was in favor of a standardized alloy, "if it is the best that can be purchased for the cost." Another stated, "A standard alloy based on the results of general railroad experience would be advantageous."

The general practice of railroads, apparently, is to order under specifications permitting a range in composition, as follows: Copper, not less than 76 nor more than 80 per cent; tin, not less than 9 nor more than 11 per cent; lead, not less than 10 nor more than 14 per cent and zinc not more than 2½ per cent. The total of other component parts and impurities is usually limited to not over 0.75 per cent. It will be noted that the average figures, as regards copper, tin and lead are 78, 10 and 12 respectively. The average formula, based on the inquiry mentioned previously, would read: Copper, 76.20 per cent; tin, 9.20 per cent; lead, 12.50 per cent; zinc, 1.80 per cent; and phosphorus 0.30 per cent. It is worthy of note that the amounts of tin and lead in this formula are close to the figures, 79-8½-12½, which expresses a medium between the two alloys 80-10-10 and 78-7-15 respectively. Some of the specifications submitted permitted of the use of 50 per cent scrap in combination with new material, but insisted that the scrap be of an exact composition similar to that of the formula covering the virgin metal. In this connection the following query is pertinent: Do railroads, as a whole, appreciate the difficulty of the task they impose on foundries producing railroad work when they bind them to close specifications and at the same time expect them to take and use a heterogenous mass of railroad scrap, the composition of which is utterly unknown?



Titanium-Aluminum Bronze Elevator Gear Wheels

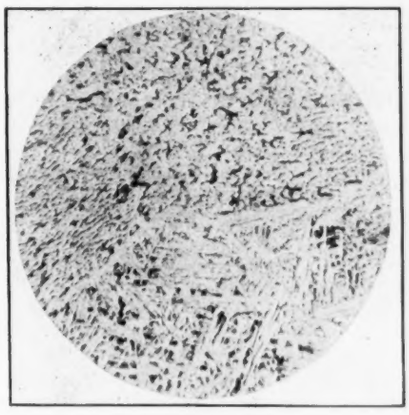
Titanium-Aluminum Bronze Stripper, Weight 1,200 Pounds

Properties of Aluminum Bronze Alloys

By W M Corse

IN MY experience with non-ferrous alloys, I have never worked with a series of metals more interesting than the copper-aluminum combination. This refers particularly to the binary alloys of copper with aluminum, with not to exceed 15 per cent of the latter metal. The main properties of these alloys have been described in considerable detail in the eighth report which was made to the alloys research committee of the Institution of Mechanical Engineers of Great Britain.

TITANIUM-ALUMINUM BRONZE NUT

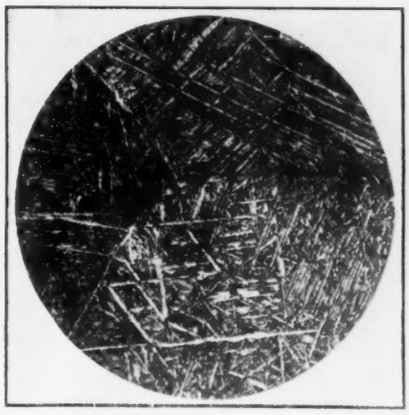


ALLOY NO. 5 HEAT TREATED BY SPECIAL PROCESS — MAGNIFIED 200 DIAMETERS

One property that is not brought out as clearly as possible, is the hardness of these alloys. Below 7 per cent of aluminum, heat treatment does not have much, if any, effect, but above that point the hardness can be varied almost at will by different heat treatments and by the addition of other elements such as iron and silicon. The heat treatment of these alloys is carefully described in the report mentioned above, but very little reference is made to any properties affected by the heat treatment except the usual ones of ultimate tensile strength, elastic limit or yield point, elongation and reduction of area, all of which are determined on one machine and on the same specimen.

It has been found that the hardness is very much affected as well as the properties mentioned. This change in hardness develops new uses for the alloys which might not be noticed unless this property is determined on the differently treated samples. This fact is of interest to engineers and other users of bronze castings, all of whom have been trained to think of bronze and brass as relatively soft materials. A hardness of over 100 Brinell is not easy to obtain unless the metal becomes brittle and therefore not always practical for the particular use in mind. Frequently, therefore, steel is used when a bronze would be preferred either on account of its non-corrosive or its anti-frictional properties, if a hard material is wanted.

Aluminum bronze alloys of approximately 10 per cent aluminum, however, possess properties very similar to a Swedish bessemer steel of 0.35 per cent carbon, including the property of being hardened by heat treatment. For instance, heating this alloy to different temperatures up to 800 degrees Cent. will give, on quenching, hardness numbers varying from 100 Brinell to 260 Brinell. This varies somewhat with the area of the cross section of the piece. Many uses immediately suggest themselves for bronzes with hardness above that of 100 Brinell, particularly, as happens in this case, if the bronze possesses good bearing qualities. Bearings, heat-treated in a manner similar to that de-

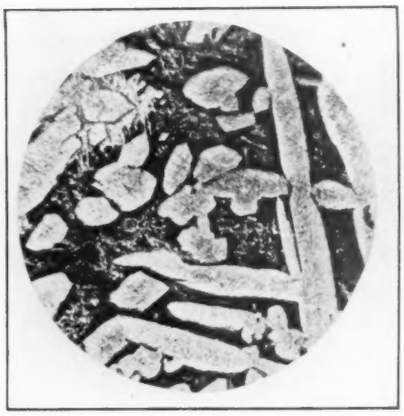


ALLOY NO. 5 QUENCHED IN WATER FROM 900 DEG. CENT. — MAGNIFIED 200 DIAMETERS

TESTS OF TITANIUM-ALUMINUM BRONZE ALLOY NO. 2

Original cast alloy:—	
Elastic limit, lb. per sq. ft.	19,800
Tensile stg., lb. per sq. in.	74,000
Elong. in 2 in., per cent...	19.5
Reduc. of area, per cent...	23.7
Hardness, Brinell No.....	100
Quench alloy:—	
Elastic limit, lb. per sq. in	40,500
Tens. stgth., lb. per sq. in.	105,200
Elong. in 2 in., per cent...	1.0
Reduc. of area, per cent..	0.8
Hardness, Brinell No.....	262
Special heat-treatment:—	
Elastic limit, lb. per sq. in.	56,700 to 39,300
Tens. stgth., lb. per sq. in.	96,700 to 91,200
Elong. in 2 in., per cent..	5.5 to 14.0
Reduction of area, per cent	9.1 to 18.5
Hardness, Brinell No.....	158 to 140

Presented at the Atlantic City meeting of the American Institute of Metals. The author, W. M. Corse, is affiliated with the Titanium Alloy Mfg. Co., Niagara Falls, N. Y.



ALLOY NO. 1 SAND CAST—MAGNIFIED 200 DIAMETERS

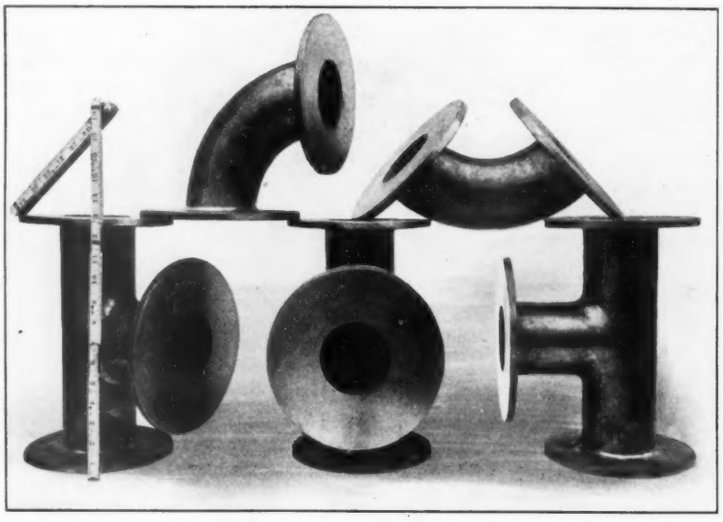
scribed, have been put into machinery running 20,000 revolutions per minute and have given excellent results. Softer bronzes were failures in such places because they would not hold their shape under the severe conditions named. Many places can be thought of where a bearing has to stand high compression, as in a bridge. For such conditions a hard bronze is essential. As stated above, it opens a new field for a metal of the properties mentioned and one which is not adequately filled at present by alloys other than the aluminum bronzes. The accompanying table gives the results of a titanium aluminum bronze, containing 10 per cent aluminum, before and after heat treatment. The apparently low elastic limit or yield point of the original cast alloy is sometimes noted in comparison with manganese bronze, but in explanation it should be stated that the aluminum bronzes show the same elastic limit under tension tests as with alternating stress tests. Manganese bronze and other strong alloys show much lower elastic limit under alternating stress tests than under tension tests.

Another valuable property of the aluminum bronzes is their ability to withstand alternating stresses without showing fatigue. The samples tested by Carpenter and Edwards and discussed in the eighth report to the alloys research committee of the Institution of Mechanical Engineers, constituted a record in this respect.

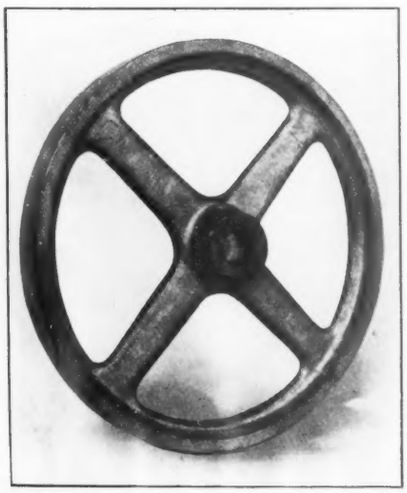
Comparing aluminum bronze with manganese bronze of the same strength, it was found that the aluminum bronze resisted stresses above its elastic limit for an average of 15 million reversals in a White-Souther machine, while manganese bronze broke at less than one million. In the Landgraf-Turner endurance testing machine the aluminum bronzes resisted 4,500 blows before fracture, while the manganese bronze resisted about 500. From an engineering standpoint this is very important because the test of the fatigue of a metal is really the nearest to the service test that can be made with present facilities.

I am glad to be able to report progress in the successful casting of aluminum bronzes, for castings made from bronzes with such valuable properties of strength, good bearing qualities, resistance to fatigue, absence of liquidation, and relatively low specific gravity should be available for many engineering specifications. In the foundry with which the writer is associated pieces have been cast weighing 1,200 pounds each and many of difficult design weighing 300 pounds to 400 pounds each. This confirms the statements in the report to the alloys research committee, that by care the usual difficulties of casting the alloy were successfully overcome.

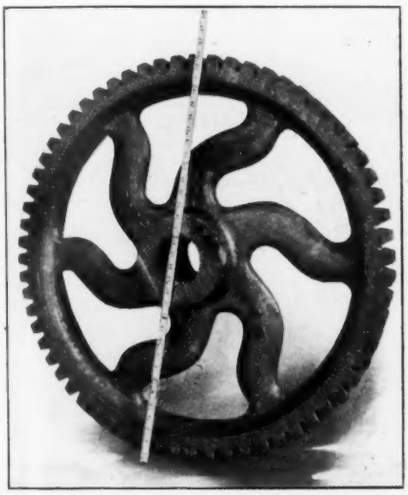
TITANIUM-ALUMINUM BRONZE AUTOMOBILE STEERING SPIDER



TITANIUM-ALUMINUM BRONZE ACID-RESISTING FLANGE FITTINGS



TITANIUM-ALUMINUM BRONZE AEROPLANE MOTOR TUNING GEAR



TITANIUM-ALUMINUM BRONZE LOCOMOTIVE GEAR

White Spots on Brass Castings

By Fred E. Melville

The article entitled "White Spots on Brass Castings," published on page 458, November, 1914, issue of THE FOUNDRY, is particularly interesting to me as the same difficulty has been experienced in the past in this plant. The mixture referred to can be improved by using the following: Copper, 85 per cent; tin, 6 per cent; zinc, 6 per cent and lead, 3 per cent. After the copper has been heated very hot, the pot is removed from the furnace for the addi-

tion of the tin, lead and zinc, the latter being added last. When the zinc has been added to the copper it is held under the surface of the bath with a skimmer. If the castings are heavy, the metal should be poured as cool as possible to permit the gases to escape. Also the metal should be skimmed two or three times and if these instructions are closely adhered to, the castings will be found to be without white spots.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Aluminum, Nos. 12 and 31

We would be pleased to have you advise us the contents of the various grades of aluminum, such as Nos. 12, 31, *etc.*

The aluminum alloy known as No. 12 consists of aluminum, 92 per cent, and copper, 8 per cent. It usually is made by adding what is known as a hardener to molten aluminum, or by melting the hardener and the aluminum together. The hardener consists of 50 per cent copper and 50 per cent aluminum.

No. 31 consists of aluminum, 81.5 per cent; zinc, 15 per cent; copper, 3 per cent, and manganese, 0.5 per cent. The manganese is frequently omitted and 0.5 per cent of copper is used in its stead.

Cores for Phosphor-Bronze Castings

We have received an inquiry for a casting to be made of monel metal and which will weigh about 175 *pounds. We would like to know how to make the cores sufficiently refractory to withstand the action of a metal of this kind and also how to make the mold. How should this metal be melted and fluxed? I am using, successfully, powdered silica and glutrin as a wash on phosphor-bronze cores. Would this prevent a high nickel and copper mixture from cutting the core, or would the latter have to be made weak on account of the high shrinkage of the metal?*

The more refractory the core and the less gas it generates, the better. Weak cores are best for all high-shrinkage metals, such as steel, monel metal, nickel and aluminum bronze. Use as pure a silica sand as it is possible to obtain. The core should have a smooth skin, free from porosity, as otherwise the metal will penetrate the core and fuse with it. Silica sand frequently is mixed with powdered silica, as much as 50 per cent of the latter being employed for steel. The material should be thoroughly mixed, preferably by milling. A silica facing also should be used on the mold. Bond the sand with clay and a sugar bond, such as molasses, and dry the mold. The facing, the same as the core, should present a smooth surface to the metal. Magnesium generally is employed for fluxing monel metal.

An Unusual Copper Alloy

We would like to know whether the following alloy has any commercial possibilities: It contains 98 *per cent copper, can be cast in dry sand molds and the castings are sound and tough and machine as easily as ordinary brass castings; the metal is hard, sonorous, and it has slightly lower expansion than pure copper. It can be hardened, tempered, welded and swaged like steel without breaking or crumbling.*

There is little doubt but that an alloy having these properties would be of value commercially, provided the cost of producing it would not be prohibitive. The alleged properties of the alloy would excite considerable interest, particularly soundness, toughness and ease of machining. Also the acid-resisting properties and the fact that the alloy can be tempered, hardened and welded, give it distinct advantages over ordinary bronzes.

However, the alloy first should be tested scientifically. Its tensile strength, yield point and elongation should be ascertained. Its strength under compression also should be known, as well as its specific gravity and hardness. From a selling standpoint it is not sufficient to state that an alloy is tough, hard and strong, because the buyer wants to know just how tough, how hard and how strong the alloy is and whether it compares favorably in these respects with the bronzes he has been accustomed to use. If the superiority of the new alloy is marked, the buyer will be favorably influenced, provided its cost does not offset the advantages of these superior physical properties. Therefore, it is important to investigate all of the properties of this alloy and to compare them with the various alloys now on the market.

Difficulties of Casting Brass on to Steel

We are in receipt of an order for U-shaped steam cookers which have brass flanges cast onto the rims. The cookers are made of No. 14 *gage steel and we would like to know whether we can cast the flange onto the rim, and if so, what mixture should be used?*

We doubt very much whether you will be successful in casting a brass flange onto a steel rim. The most practical method of handling the work would be to cast the flange separately and attach it to the cooker by welding with the oxy-acetylene blow pipe. A suitable mixture for the flange follows:

Copper, 88.50 per cent; tin, 5.50 per cent; zinc, 3.50 per cent, and lead, 2.50 per cent.

"Yellow Metal"

We are casting a bronze of the following mixture: Copper, 74 *per cent; tin,* 7 *per cent; lead,* 4 *per cent and yellow metal,* 15 *per cent. The mixture is satisfactory in every particular with the exception of toughness and we would like to know what we could add to obtain a tougher material. Does not the term "yellow metal" refer to yellow brass?*

The reason this alloy is deficient in toughness is that it contains too much lead and we suggest that it be changed as follows: Copper, 88 per cent; tin, 7 per cent; zinc, 3.5 per cent, and lead, 1.5 per cent. The term "yellow metal" is usually applied to yellow brass and in this case it is used merely to introduce zinc into the mixture.

There is no objection at all to its use in this manner, provided the analysis of the yellow brass is known. Since yellow brass differs considerably in composition there is nothing definite about the amount of zinc that is introduced into the mixture and for this reason it is better to use zinc direct.

How Aluminum Chips Are Recovered by Melting

Various Processes Are Discussed and Instructions Given Whereby as High as 70 Per Cent of the Metal May Be Reclaimed

By H W Gillett

IF A foundryman attempts to melt down the No. 12 alloy chips made in machining aluminum castings for automobiles in the same way he would melt brass chips, either by adding them in small amounts to a pot of metal, or melting them alone, he usually recovers somewhere between 50 and 70 per cent of the chips into a pool of metal in the bottom of the pot and loses from 30 to 50 per cent in a light fluffy dross that, as soon as the air strikes it, gets excessively hot, glows with a blinding light and smells of ammonia when moistened.

One naturally supposes that the cause of this dross formation is the great affinity of aluminum for oxygen and that the dross comes from oxidizing conditions within the furnace. Foundrymen frequently are told that to melt aluminum borings one should get a pot half full of molten metal and then stir the borings in so as to cover them with metal and keep the air away from them, finally fluxing with sal-ammoniac or zinc chloride. The trouble is that the borings prefer to stay on top and refuse to be stirred in.

If the borings as is usually the case are contaminated with even 2 or 3 per cent of fine dirt, such as floor sweepings, one can melt in a closed retort, or in an electric furnace in the entire absence of oxygen, and still get very low recoveries and copious amounts of dross.

Where the Trouble Lies

The real trouble lies in the fact that a large proportion of the chips are only about 0.005-inch thick, and will pass a 20-mesh riddle. When such a chip melts it forms a globule of metal about as big as a pin point. Each chip has had an infinitesimally thin film of oxide on it, formed the moment it was cut. That such thin films prevent metallic contact between aluminum surfaces is plain from the fact that a bundle of aluminum wires may be twisted together and brought up to the fusion point without welding together at all unless they are forced together so that the film is ruptured or unless a flux that will dissolve aluminum oxide is used.

Each little pin-point globule is then surrounded by a film of oxide, infinitesimal in thickness or weight, but yet sufficient to keep the globules from uniting. If any fine dirt is present, this reinforces the oxide armor and makes matters worse.

So our dross, instead of being mainly aluminum oxide, is mainly tiny globules, separated by films of oxide and dirt. Were this not the case, and were the dross all oxide, it would not get hotter on striking the air when skimmed off. Thus, while the cold dross is oxide, the hot dross is an emulsion of metal droplets kept separate by a solid honey-comb-like structure of oxide and dirt.

The problem is then, mainly one of getting these tiny droplets to coalesce and to free themselves from the dross. The common method is to stir sal-ammoniac or zinc chloride into the dross. These fluxes, so-called, are really mainly stirrers. They gasify at temperatures below the melting point of aluminum and the violent evolution of gas tosses the mass of dross about, throws some of the globules together with such force that the enveloping film is ruptured and a few of the globules coalesce. But the volatile fluxes are not very efficient stirrers and the dross, after they are used, still burns up in the air almost like a flash-light powder, because of the metallic aluminum still left in it.

It is, of course, desirable to melt in a reducing atmosphere, if possible, but oxidation within the furnace is far less troublesome and far more readily overcome than the reluctance of the globules to coalesce.

Many methods of melting chips have been suggested, ranging from the use of vacuum furnaces to that of patent fluxes with enticing names at 25 cents per pound. Two methods, both of which aim to promote coalescence, are in use by two firms refining aluminum chips on a large scale, and give good results.

The first of these is the "puddling process". The melting is done in oil-fired furnaces, using iron pots, the furnaces being provided with close fitting hoods. The empty pot is heated up to a low red, and a few shovels of chips are put in. The furnace tender stands by with a big skimmer and works the chips over constantly till they start to get pasty. Before they are fully melted, he adds another small dose of chips and works them into the dough-like mass. The mass is not allowed to get visibly red. The addition and the working over of the chips is continued until the pot is full, holding the temperature practically at the melting point. By the constant stirring of the pasty mass, the tiny globules are pressed together, and the films of oxide and dross broken through, so that the result is a uniform pasty mass of metal, enveloping particles of dirt and oxide instead of a little molten metal below and a mass of dirt and oxide enveloping globules above. The pot is then covered and the metal heated to about 700 degrees Cent. or 1,300 degrees Fahr. until the dirt and dross rise.

Zinc chloride is then stirred into the risen dross, which is skimmed rapidly into water so as to stop oxidation and allow the recovery of entrained metal.

Recovery by Puddling

This method gives about 70 per cent recovery on the ordinary dirty borings of commerce. On borings cut with a water-soluble cutting compound, if the wet borings are allowed to dry out in the air, to oxidize and cake up, the recovery by this method is 50 to 60 per cent. But if these borings are very carefully kept free from dirt and are promptly dried, after cutting, by a centrifugal process, these clean, dry borings give 85 to 90 per cent recovery by this process.

The puddling process requires the constant attention of the furnace tender, and the daily output per man is small.

The other process is based on the same principle as that of welding aluminum, where fluxes composed of chlorides and fluorides of the alkalies or alkaline earths are used to dissolve the film of aluminum oxide and to allow the metal surfaces to unite, fluorides being the best known solvents for aluminum oxide as well as

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good ones for siliceous dirt. The chips are intimately mixed before charging with large amounts, 20 to 50 per cent of the weight of the chips, depending on their degree of cleanliness, of a flux consisting of about 85 per cent common salt and 15 per cent powdered fluorspar. The mixture of chips and flux is put into large crucibles, heated in a coke fire. As soon as the chips start to melt, they are jammed down to make room for more mixture, and so on until the pot is full.

The pot is then left undisturbed without stirring, until the flux is fully melted, and fluid enough to absorb the oxide and dirt either by true solution, or by soaking it up mechanically, the tiny metallic globules falling through and collecting in a molten mass. This requires at least 900 degrees Cent. or 1,650 degrees Fahr. On absolutely clean borings, this method gives 90 to 95 per cent recovery, while chips very foul with dirt may give but 65 per cent. This method cannot be used in iron pots because the temperatures required are too high for reasonable pot life. It will probably require more fuel than the puddling method because of the higher temperatures and because so much flux must be heated up. The flux, although it has to be used in large amounts, is so cheap that it is hardly more expensive than the zinc chloride used in the puddling method. The crucible expense will be a little higher than that for iron pots in the puddling method, but the labor cost should be very much lower.

Moreover, it is quite possible that by increasing the amount of flux to correspond with the greater surface of the metal bath in a reverberatory furnace, that the salt fluorspar flux method might be used in reverberatory melting.

On tests of a lot of commercial borings containing some 10 per cent of very fine dirt, the average recoveries, figured on the true metallic content of the chips, were as follows:

	Gas-fired crucible furnace	Electric crucible furnace	Small gas-fired reverberatory
No flux, per cent	55	..	.....
Volatile fluxes, sal-ammoniac, zinc chloride, etc., with stirring but without constant puddling, per cent	65-70	70	50-60
Retorting or stirring into molten metal, per cent	65-70	..	.....
Briquetted chips stirred into molten metal, per cent	75	..	.....
Puddling process, per cent	70-80	..	.....
Salt fluorspar flux, per cent	75-85	85	80-90
Briquetted chips with salt fluorspar, per cent	90	..	.....

Experiments have indicated that dirty, oily borings might be cleaned by washing with a weak caustic soda solution, perhaps freed from dirt on a concentrating table and dried by centrifugal force, but whether such cleaning would pay commercially is a question. It is also an open question whether briquetting will pay commercially. But it is certain that keeping the borings scrupulously clean and free from dirt or dust, keeping them free from contamination by iron or brass chips, and removing water soluble cutting solutions, are advisable, and that the higher recovery from clean chips will pay richly for a little extra care in the machine shop.

Ingots obtained from borings by either the puddling or the salt-fluorspar process can be used in many simple castings up to 25 per cent of the mixture without detriment to the quality or strength of the castings and without an increase in foundry defectives. If iron is kept out, the composition will not change materially in refining, and, if desired, a furnace or two can be kept busy on borings, and the molten metal mixed in the desired proportions with new metal from other pots, the castings being poured direct without reheating the metal obtained from the chips.

The Chipping Boss as an Optimist

By Clayton Yost

NOT being able to find the official definition of a cleaning or chipping floor in any standard dictionary, we are forced to give our own, which is that a chipping floor is a place or shop where trouble is dumped in heaps. A properly conducted chipping shop is an international aid society, for it can furnish brakemen for yard engines, helpers for tired and weary molders, men to carry pots, men to melt brass, or to fill up the gaps in an open hearth furnace gang. It can furnish men of every race and color. The cleaning and chipping floor of a steel foundry is not noted for its peace and quietness, nor is it known for that calm and tranquil state that will so often be found in the office. Between the dirt and the dust from the castings, the smoke from the engines and annealing furnaces, and the glare and flare from the welder, it was very aptly described by the new man during his first morning's work when he said, "I always knew I would reach Hell some day and have got there at last." Yet, on a chipping floor the men do things; all are hustlers and it is a mighty poor place for drones. All are wide awake. It is there that promises are kept, not made; it is there that new questions arise daily regarding the work and the castings, and it is there, amid the dust, the dirt and the noise, that those questions are solved. In shops where many pieces of different sizes and shapes are handled, the operators always are in danger. A colored man once hired as a chipper by the writer, was started at work under an overhead traveling crane. The new man watched the crane traveling up and down the shop several times, and then said: "Say, Boss, does that train

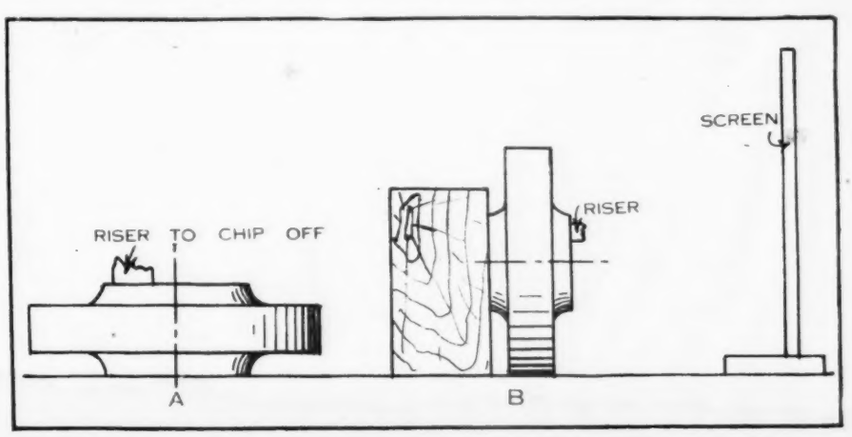


FIG. 1—CORRECT AND INCORRECT POSITIONS OF CASTING AND SCREEN

run over me all day long? If it does, I quit right here."

The greatest dangers in a chipping shop are not those that can be seen, but arise from the particles of sand, steel and iron that are continually in the air. The greatest danger is from cast iron, from cores that consist of a mixture of steel or iron and sand and from steel of from 0.70 to 1.10 per cent carbon. This high carbon steel is hard to chip, and whenever possible, chipping should be eliminated and the work should be done by grinding or with machine tools.

When chipping fins, risers or runners from a casting, it would be well to have the piece, whenever possible, set on edge while the work is being done; by pursuing this practice the danger from flying chips is greatly reduced. When chipping a casting in the position shown at *A*, Fig. 1, the chips will pass over and around the screen. With the casting in the position shown at *B*, the chips have a tendency to fly straight out into the screen, or down into the dirt. Perhaps this point is too small to consider, but it doesn't take a large chip to destroy eyesight, and in this case the small things loom large. Air tools greatly reduce the number of accidents in a cleaning room, and it is found that the men prefer work that requires pneumatic tools.

When goggles are first worn there will be some trouble with the men wearing them on their forehead, but today, owing to the very great improvement in the style of goggles used, there should be very little difficulty in this direction. Only constant watchfulness on the part of the foreman will do away with the blurred and battered ends of sets and bars.

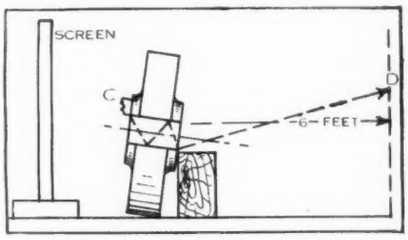


FIG. 2—A PECULIAR CHIPPING ROOM ACCIDENT

Screens should be kept on the chipping floor and should be used. It is advisable that more than the number required be kept on hand. They should be substantially made for they are subject to hard wear, and the men should learn that they are not furnished to be used as couches at noon or at midnight. The screens should be made with a rough, soft wood frame covered with canvas or burlap, and should be kept in good repair, for chips have a tendency to find the torn part of a screen. It is a serious mistake to use screens with a frame work of iron piping or fitted with iron work of any kind. If a chip should strike the iron work, it will glance off at right angles or perhaps rebound and injure the men chipping. In some shops all the dangerous chipping, whenever possible, is done toward a blind wall. This is good practice, but screens should always be used to stop the rebound of the chips.

There are times when screens do not screen. The writer was once standing on a chipping floor among men chipping cast iron wheel centers, and was talking with the young man in charge of the work when he was suddenly struck in the face with a chip. Investigation indicated that the accident occurred as illustrated in Fig. 2. The men were chipping down the riser shown at *C* when a chip flew into and through the center core of the casting, as indicated by the dotted line, and struck the young man at *D*. When struck he was standing about 6 feet back of the casting.

Suggestions for Reading Working Drawings

By Fred West

BOTH foundrymen and patternmakers frequently are compelled to read working drawings. It may arise that a certain construction already contracted for has to be made, or a prospective client may bring in his drawing for the purpose of getting expert advice. In any event, the man who is not versed in reading working drawings is at a disadvantage, as he stumbles through the interview unsatisfactorily to himself and to the prospective customer. The purpose of this article is to set forth concisely and in simple language the directions all those who wish to learn this interesting subject must follow.

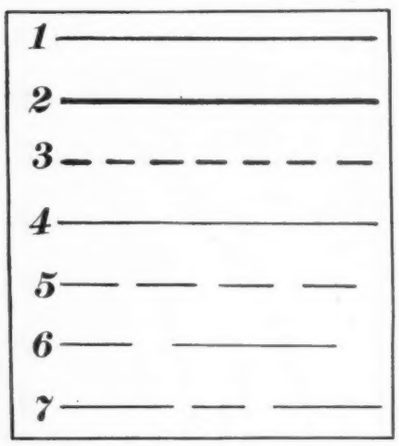


FIG. 1—SEVEN KINDS OF LINES USED ON WORKING DRAWINGS

A working drawing of an object consists of one or more views, drawn and arranged in relation to each other, so as to show the size and shape of the object and the kind of materials in its construction. A working drawing shows the object in an entirely different way than a photograph, yet the plan is such that all technically informed people, regardless of their language, can understand the same drawing. The established system of making working drawings, therefore, is well-termed a *universal language*. The only exception to this is the writing or special lettering that may be put on some drawings and which might not be readily understood by all nationalities. Once the alphabet of working drawings has been learned, the reader will have no difficulty in quickly understanding drawings of complicated devices.

The *ABC* of working drawings consists of the kinds of lines used, the projection or view method and the arrangement of the views on the paper. The lines employed and their widths or *heaviness* are shown in Fig. 1. There are seven of these as follows:

1.—The full line used for all the

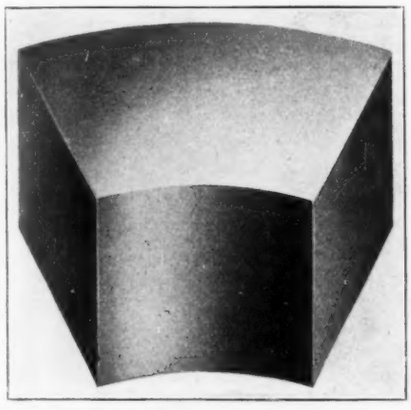


FIG. 2—PHOTOGRAPHIC REPRODUCTION OF CUPOLA LINING BLOCK

visible outlines except where *2* is employed; *2*—Heavy, full line used in place of *1* on some drawings and with *1* on the shaded side of drawings; *3*—dotted line used to show invisible outlines and must correspond in width to *1* and *2* used on the same drawing; *4*—light, solid line used for penciling and cross-hatching; *5*—short dash line used for projection lines connecting the same points on different views and is the same width as *4*; *6*—long dash line used for dimensions, it is made the same width as *4*; *7*—dot-and-dash line used for section lines and center lines and drawn the same width as *4*.

Fig. 2 is a photographic reproduction of an object, and Fig. 3 illustrates the view method of presenting a working drawing of this object. Instead of

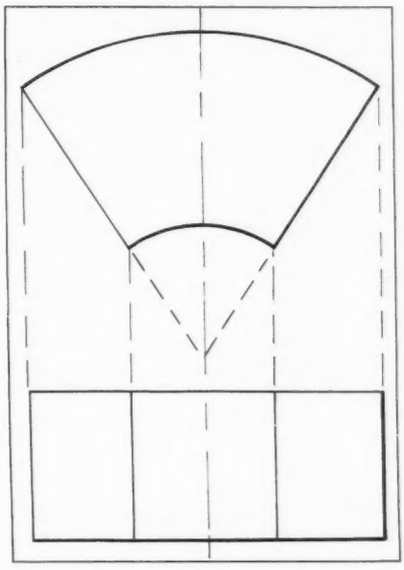


FIG. 3—DRAWING OF CUPOLA LINING BLOCK

showing one general view including three faces of the object as in Fig. 2, the working drawing gives separate views. The important thing to note is that each of these views represents the true outline of the object. Each view is exactly the same as that which would be made by placing the object on the drawing paper and passing a pencil around it. The views of the working drawing are, therefore, the actual views and not the distorted or perspective view presented in a photograph. The difference between a perspective and a working drawing may be seen in any street view. In the distance the street seems to become narrow and the sides meet. But as the sides are actually parallel, the working drawing shows them as they actually are instead of converging.

The third *ABC*, or the arrangement of the views, is shown in Fig. 4. The top view is placed above the front view, the bottom view below it, and each of the end views is at that side of the front view nearest the end that it shows. In other words, the right hand end view is at the right, and the left hand end view is at the left. In some

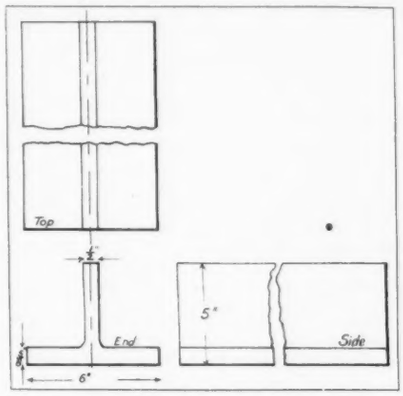


FIG. 4—ARRANGEMENT OF VIEWS OF A SECTION OF TROLLEY RAIL

cases the front view is called the elevation, and the top view the plan.

It will be observed that all of the views around the front view are arranged so that their parts nearest the front view represent the front of the object. This can be understood by imagining all the views in Fig. 4 hinged together. Then suppose that the front view be lifted from the paper, allowing

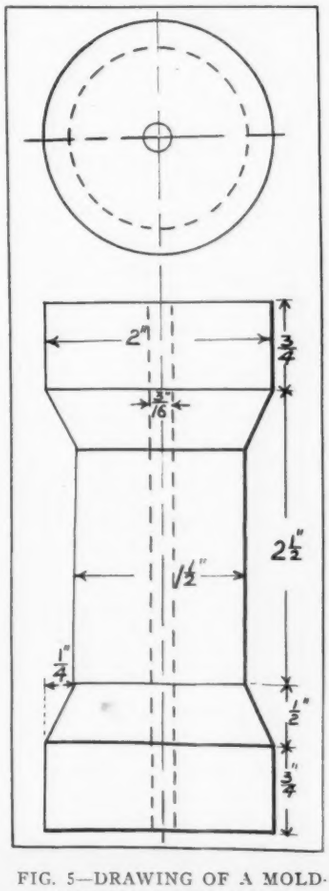


FIG. 5—DRAWING OF A MOLDING MACHINE VALVE

all the other views to swing into a vertical position and form a box enclosing the object itself. The relationship not only of the different views to each other, but of the edges adjacent to the edges of the front view will now be apparent. Finally, it will be seen that the vertical measurements on the end views and the horizontal measurements on the top and bottom views are the same as the like parts on the front view.

The use of the different lines in Fig. 1 is illustrated in Fig. 5, which is a working drawing of a molding machine valve. By comparing each of these lines and its use and location with the definitions given in connection with Fig. 1, the application of this system will be readily understood.

When the outline views do not give all the information required about the

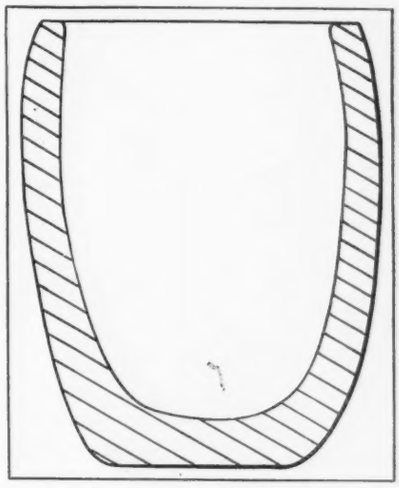


FIG. 6—CROSS-SECTION OF A CRUCIBLE

construction of an object, it is often necessary to show views of its interior. These are called cross-sections, and are made as shown in Fig. 6. In this case the object is represented as though it were cut through on a certain line. The inside edges are drawn in full and the surfaces thus formed are cross-hatched with slanting lines.

As it is not convenient or possible to make all working drawings full size, it is customary to draw the views to some special dimensions called scales. Several scales are used to make all the drawings of uniform size. Thus, the drawings may be laid out so that ½ inch on the paper represents 1 foot on the object. In a similar manner ¼ inch, ⅛ inch, or 1 inch, etc., may be used. In all cases, however, the actual dimensions of the object are written on the drawing no matter what scales are used.

The scale is marked on the drawing so that where dimensions are omitted, the lines may be measured and their

true lengths calculated. It is customary to use more than one scale on the same drawing. This is done where there are many parts different in size, and where it is necessary to enlarge some and to reduce others. When some parts are too long to be made conveniently by the scale, portions may be broken out, as shown in Fig. 4.

An Inexpensive Base Plate Pattern

By S B Phelps

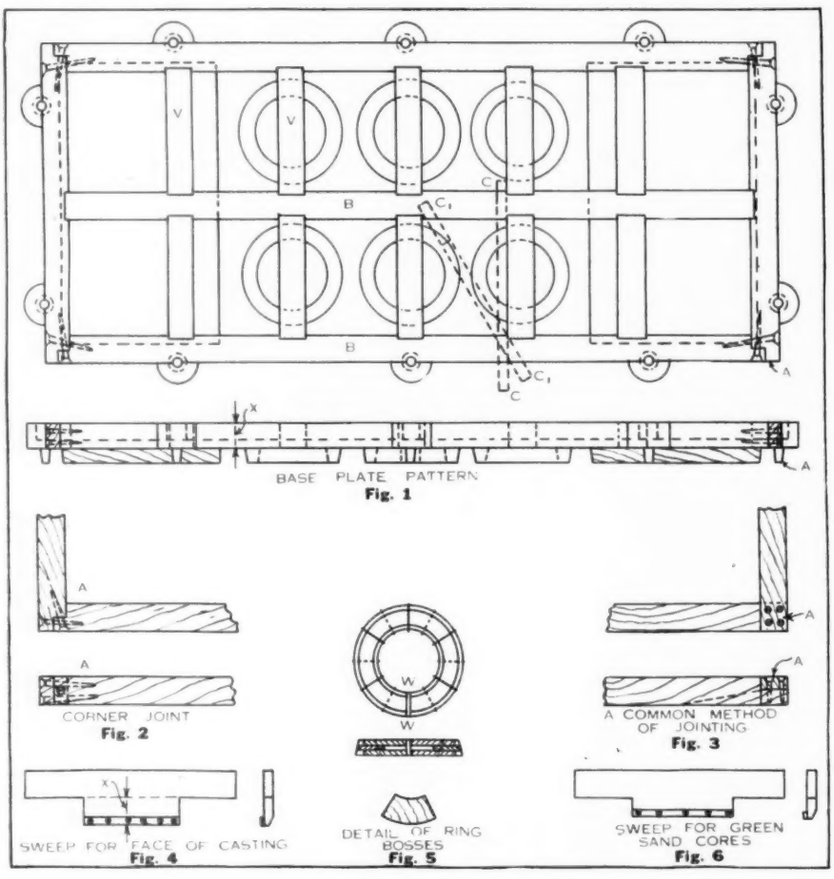
INASMUCH as only a few base plate castings were to be made from the base plate pattern, shown in the accompanying illustrations, it necessarily had to be inexpensive and as a result, its construction involved a number of interesting features. The pattern was 17 by 8 feet, 6 inches over all and it was molded with the pads in the drag to insure sound metal where it was machined. A frame was made of 2-inch stock which was fitted, as shown in Fig. 1. The flat pads were attached with screws at either end and the bosses for the foundation bolts were nailed to the frame. If the round bosses in the center had been turned on the lathe in the usual manner, considerable time would have been consumed and the patternmaker decided to cut them out with a saw. As there was no jig saw in the shop a method had to be devised for doing this work on the hand saw. Three rows of segments were laid up to make the bosses, with the exception of one segment in the middle row, which was not glued nor nailed in place, but was left loose, as shown in Fig. 5. When ready to saw out the center, the patternmaker merely pulled the rings apart sufficiently to allow the joint at *WW* to slip past the band saw. The loose segment then was tacked in place and the inside circle was cut to line. Next the loose piece was removed and the boss was spread again to clear it from the saw. The loose piece then was glued and nailed in position and the outside circle was cut to line. The bosses next were smoothed at the bench. These bosses could have been sawed out in the center by merely cutting through the rim instead of leaving a loose segment as shown, but it would not have made quite so good a job and would not have been as strong. In many cases molders prefer to leave these bosses loose in order to get a good draw after the main portion of the pattern has been drawn from the mold. If such had been the case in this instance, the bosses would have sprung when they were rapped and it is possible that the molder would have broken them.

All parts of this pattern were given sufficient draft, as this could not impair the design. Draft was allowed especially on the ring bosses and on the ribs which formed the lightening cores on the main part of the pattern, since these cores were lifted in the cope, as shown at *B*, Fig. 1. This saved time in patching the mold and also increased the chances of obtaining a good casting.

Since the pattern had to be bedded in the floor and inasmuch as molders frequently use heavy sledges to bed the drag in the soft sand, the joints, if they had been made in the usual way, shown in Fig. 3, undoubtedly would have parted. If the molder strikes the pattern with the sledge at the point shown at *A'*, Fig. 3, the pattern frequently will break, as indicated by the dotted line. For this reason the joints were made as shown in Fig. 2. The method of jointing shown in this illustration also is advantageous, since the stock can be cut to line on the band saw and the stock will form a good joint when put together. On the other hand, if the stock has to be placed on edge on the saw table to cut it for the type of joint shown in Fig. 3, the band saw must be in first class condition and the stock absolutely square to obtain a good joint. If this is not the case, the joint will be undercut, requiring extra time to trim to line at the bench.

The sweep, shown in Fig. 6, was made to prepare the bottom of the mold for the lightening cores of the main part of the pattern. These were rammed with the cope. Another sweep was made, as shown in Fig. 4, to remove the sand left between the green sand cores and the bottom of the mold to get the required thickness of metal for the face of the casting. In making the sweeps, a strip of sheet metal was attached to the lower parts to give them sharp edges

(*Continued on page* 469.)



DETAILS OF AN INEXPENSIVE BASE PLATE PATTERN

The Corrosion of Steel and Cast Iron Compared

By R C McWane and H Y Carson

Fig. 1—Wrought iron pipe, showing effects of corrosion

Fig. 2—Cast iron pipe, still serviceable

FROM out the maze of chemical controversy of recent years as to the cause, or causes, of rust, stands the fact that cast iron resists the action, or actions, that prove so quickly and so completely destructive to wrought iron or steel and with this fact chemists have never yet been able to reconcile their theories. In all the chemical, or electro-chemical theories so far advanced, cast iron has been shown to be most susceptible to rust, because of the larger percentage it contains of foreign matter, such as graphite, silicon, manganese, sulphur and phosphorus, yet the facts of history prove that while cast iron will become quickly coated with rust, it will remain practically unimpaired in weight and strength for hundreds of years under conditions that prove absolutely fatal to wrought iron or steel in 10 to 20 years. These facts indicate, therefore, that we must look to other than chemical causes for a satisfactory explanation of the phenomenon of rust damage, and the theory which seems to be most nearly in harmony with the facts, but which has received scant attention in the discussion of this subject heretofore, is that of the marked difference in *structure* between cast iron and wrought iron and steel. This difference is graphically shown in Figs. 4 and 5, these illustrations being reproductions of actual photomicrographs.

Whatever may be the accepted theory of the actual process of rust, whether the hydrogen-peroxide, the carbonic acid or the electrolytic, the three most generally accepted theories at present, it is unanimously agreed that the process is a form of slow combustion, with the presence of oxygen as an all-important factor, and that if the material can be fully and permanently protected, to exclude oxygen, rusting will not take place.

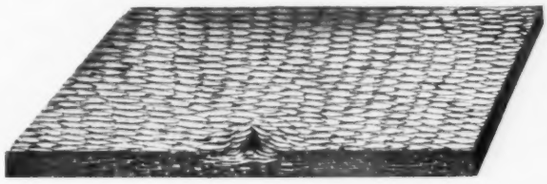


FIG. 3—DRAWING OF A PIECE OF SHEET STEEL, MUCH ENLARGED, SHOWING SURFACE AND SECTIONAL STRUCTURE WITH A TYPICAL PIT

By reference to Fig. 4, it will be noted that cast iron has a distinct granulated, or crystalline structure, a form common to all metals having undergone the simple process of smelting and cooling, which was one of the processes of nature in the formation of the ore, and it is this distinctive structure, in combination with the chemical, or electro-chemical, action taking place on the surface of the metal which serves to stop that action after it has proceeded to a certain depth, and hold the result (ferrous oxide) as a permanent, oxygen-excluding protective coating. This stoppage of rust action results from the fact that the crystals, or granules, in cast iron are bound together at one or more points by a metallic bond, or bonds, and after a rust coating has been formed of the loose crystals on and near the surface of the metal, and the oxide penetrates between the crystals more strongly bound together, the force exerted by the absorption of moisture is not sufficient to separate the crystals, and the oxide remains as permanent coating.

The undisputed fact that from the moment we begin to manipulate cast iron by puddling and rolling, we lay down the barriers for the invasion of rust, and the further well-known fact that the thinner a sheet of wrought iron or steel is rolled the more rapidly it will succumb to the action of rust, leads to the conclusion that the change in structure brought about by such manipulation has a most important, if not altogether final, bearing on this much discussed and debated question.

Passing over the intermediate processes, from cast iron to the extreme of thinly rolled sheet steel, we find the structure of the metal to have changed from crystalline to fibrous and finally to distinct laminations, or leaves, and in each process of heating and rolling the natural bond found in the crystalline structure of cast iron has been further disturbed, until in the steel sheet we find the leaves bound together largely, if not altogether, by the force of compression, yet distinctly differentiated one from the other by the very small percentage of silicon always present but uncombined with the steel.

The rusting of steel is evidenced by a form of pitting and exfoliation, or flaking-off of minute particles of metal, exposing a new surface for attack, from time to time, until the entire section is affected. This can be clearly understood by reference to Fig. 3, which is from a drawing made to represent a piece of sheet steel, very much enlarged, showing a sur-

A paper read at the twentieth annual meeting of the American Foundrymen's Association, Atlantic City, Sept. 28-Oct. 1.

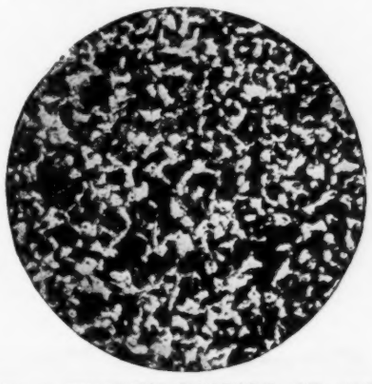


FIG. 4—PHOTOMICROGRAPH OF CAST IRON

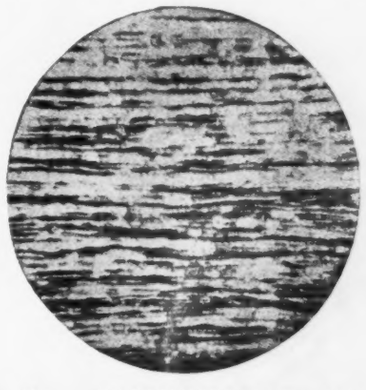


FIG. 5—PHOTOMICROGRAPH OF WROUGHT IRON

face and sectional structure, and a typical *pit*, which is likely to occur at various points in sheets apparently well-protected with paint or other coating. Uncoated sheets will scale off much more uniformly, and despite the claims of various manufacturers in the past few years of having produced a coating that will successfully and permanently adhere to the smooth surface of rolled steel, rust damage to such steel goes on apace, especially in locations where it cannot be watched and the coating frequently renewed.

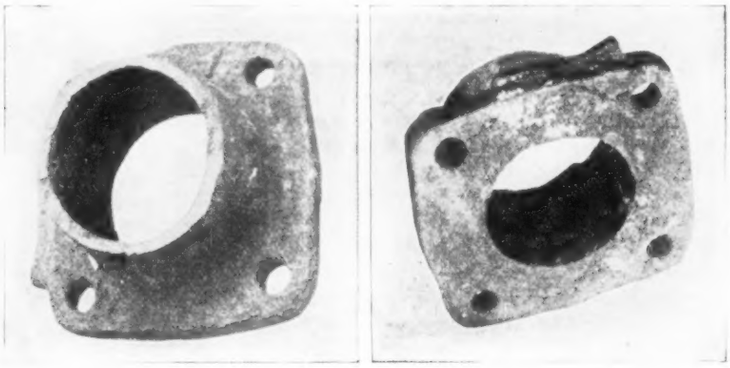


FIG. 6—PIECES OF CAST IRON PIPE FROM AN UNDERGROUND LINE INSTALLED BEFORE 1685

An important factor in the scaling-off or breaking up of the surface of rolled steel, and one which has seldom been considered heretofore, would seem to be the forces of expansion and contraction as offering a reasonable and satisfactory explanation of the rapid deterioration of such steel when exposed to sudden and violent changes in temperature. These changes, taking place on the surface of the metal before the interior portions are affected, tend to buckle, or stretch, the surface metal and to tear the laminations apart or open them up so that rust action is accelerated.

The change in structure from a crystal of appreciable size, bound to its fellows by a metallic bond, to an infinitesimally thin leaf, with no bond strong enough to resist the efforts of the rust coating to tear it away from its fellows, is a thoroughly understandable and logical explanation of the effect of rust on the two materials.

No more striking illustration of the lasting, or rust-resisting qualities of cast iron is afforded than the pieces of cast iron pipe shown in Fig. 6, the photographs having been taken in Paris, France, in 1909. These pieces of pipe are from an underground line installed prior to 1685 for the purpose of conveying water to the famous fountains in the Versailles park, and official report says that when taken up this pipe was "in apparently as good condition as when installed". Figs. 7 and 8 illustrate the relative effect of rust on cast iron and wrought iron. The cast iron shown here was used in the same service with the wrought iron and for the same length of time, and shows no sign of deterioration, while the wrought iron is completely destroyed.

Cast Iron Pipe for Plumbing

Perhaps no field affords a better means of studying iron pipe corrosion at first hand than pipe contained in the plumbing of buildings. First, this is due to the fact that both wrought iron and cast iron pipe have been installed and used in the waste lines of buildings during the past 20 years; second, old buildings are continually being torn down or remodelled, so that it is possible to obtain specimens of pipe which have seen long service; and third, when such a pipe line fails the sewer gases escape from it and render poisonous the atmosphere of the building.

Corrosion in waste and vent pipes is tributable to the moist condition of the air within the piping system, together with the hydrogen sulphide (H_2S) and carbon dioxide (Co_2), products of bacterial decomposition of sewage, which may be considered as dilute acide reagents attacking the internal surface of the pipe. Such are the normal conditions analagous perhaps to the damp air of cellars where it is so common to note the corroding of iron taking place at a fairly high rate. In many drains and vents the corrosive action is found to be even more severe than this. Where hot water or steam is discharged into the waste pipes, or where strong acids, disinfectants or other strongly corrosive substances are discharged along with the waste water into the lines, the corrosion of wrought iron or steel is accelerated and the lines break down in 5 to 10 years after being first put into use. To explain the wide difference that exists between the life of cast iron pipe and wrought pipe, none of the theories can be made to fit the facts. Indeed, they are in direct oppostion to the facts.

Typical is the comparison offered by the installation illustrated in Figs. 1 and 2, which gives a comparison of the durability of cast iron and wrought iron soil pipe joined together and used in the same 5-inch drainage stack for 18 years. The wrought iron pipe in all cases indicates a continuous peeling off of rust scales, until the whole section is destroyed, while cast iron pipe is unimpaired by the same corroding action which destroys wrought pipe. The cast iron pipe shows, when removed, a closely adhering rust coating on the surface, which undoubtedly prevents the destruction of the pipe. The loss in weight and original thickness of cast iron pipe by 18 years of service was something less than 1 per cent, while that of the wrought iron pipe was more than 72 per cent. It is not unlikely that the greater part of the 1 per cent loss in cast iron pipe actually took place during the first year the pipe was put into use, since this pipe is not tar-coated, and it is well-known that the surface of uncoated cast iron pipe corrodes very quickly. It is probable that uncoated iron pipe will show a higher initial loss by corrosion during the first few months of service than would be shown in

FIG. 7—EFFECT OF RUST ON CAST IRON

FIG. 8—EFFECT OF RUST ON WROUGHT IRON

the wrought iron pipe subjected to the same corrosive action during the same period of time.

Observing the manner in which all rolling mill products corrode, we must necessarily attach a great deal of importance to the microscopic structure of the iron. The same typical flaking-off of rust scales may be observed on rolled beams, round or square bars, or any other of the many products which are turned out of the modern rolling mill. In every case the material showing this typical flaking-off has a highly laminated structure, made so by the modern methods of its manufacture.

Ancient wrought iron or steel, and even that made 100 years ago, is known to have resisted corrosion much better than the modern wrought iron or modern rolled steel. There can be no question but that old iron does not have the same physical structure as the modern milled product, because ancient iron was smelted from the ore by crude methods into small-size pieces of metal and then hammered—not rolled—into its finished shape. Had the ancient iron been highly laminated like modern steel, it could not have lasted more than a few years.

An Inexpensive Base Plate Pattern

(*Continued from page* 466.)

and to increase their life. Frequently sweeps are made so long that they have to be forced into place between guides, as at *B*, Fig. 1, and this would prevent the molder from sweeping flush with the cross ribs, the sweep fitting too tight to be used. It also would prevent him from swinging the sweep in starting, as shown by the dotted line, *C*, Fig. 1, because the diagonal corners of the sweep will not clear the guides. It is advisable to make the sweep at least one inch shorter than the space between the guides to allow for clearance, but this is best determined by the patternmaker himself. The length of the sweep, *CC*, should be sufficient to permit the molder to swing the sweep at least 2 feet before the end slides off the guides.

Attractive Folder

The American Blower Co., Detroit, has issued a handsomely illustrated folder containing post card views of the plants of the Ford Motor Co., Studebaker Co., Parke Davis & Co., Semet-Solvay Co., Morgan & Wright, Detroit Stove Works, Michigan Stove Co., Berry Bros., D. M. Ferry & Co., American Blower Co. and Maxwell Motor Co. These 12 plants are said to be the largest in their respective lines in the world.

Chilled Car Wheels

By W. J. Keep

Question:—We are making chilled car wheels, using the following mixture: 25 per cent of iron containing 0.25 per cent phosphorus, 0.46 per cent silicon, 0.028 per cent sulphur and 0.53 per cent manganese; 20 per cent chilling iron containing 1.20 per cent phosphorus, 0.50 to 0.60 per cent silicon, 0.08 per cent sulphur and 1.30 per cent manganese; 10 per cent Swedish iron containing 0.07 per cent phosphorus, 1.25 per cent silicon, 0.015 per cent sulphur and 0.10 per cent manganese, together with 15 per cent steel scrap and 30 per cent machine shop scrap. The foundry mixture is too expensive and we would like to have you recommend a cheaper one which would be satisfactory. Also, what size chills should be used and how long should the wheels be left in the chills? As a rule, we aim to take the chills out three minutes after they are poured and transfer them to an annealing oven which holds about 60 wheels. We have found it necessary to anneal the wheels for 18 hours. Should it be necessary to anneal them if the mixture is correct?

Answer:—In figuring your mixture from the irons given, with machinery scrap containing phosphorus, 0.45 per cent; silicon, 1.75 per cent; sulphur, 0.09 per cent and manganese, 0.70 per cent, you will find that your mixture will analyze as follows: Phosphorus, 0.45 per cent; silicon, 0.87 per cent; sulphur, 0.05 per cent, and manganese, 0.61 per cent. Allowing for the losses and gains in melting, the final analysis should be as follows: Phosphorus, 0.45 per cent; silicon, 0.62 per cent; sulphur, 0.08 per cent and manganese, 0.50 per cent. A good car wheel mixture should analyze as follows: Phosphorus, 0.30 to 0.40 per cent; silicon, 0.50 to 0.60 per cent; sulphur, 0.08 to 0.10 per cent and manganese, 0.50 to 0.60 per cent. It is customary to keep the silicon somewhat lower and the sulphur considerably higher than you have it and, therefore, you can use cheaper pig irons than now employed. Your question indicates that the wheels are finished and if so, do not try to cheapen the mixture. In this country we have plenty of car wheel scrap. After you have run a sufficient length of time you can exchange new wheels for those which are no longer serviceable and this has a tendency to reduce the cost of the mixture.

The wheels should be annealed in pits slightly larger in diameter than the wheel and after shaking-out, the wheels are piled into these pits on top of each other. When the pit is full it is covered, the wheels being sufficiently hot to anneal themselves, about 18 hours being required for this operation. In Holland you seem to be able to purchase chilling irons suitable for this work. The scrap wheels from your mixtures will be very good, but when you are doing enough business to afford it, a chemist can make good car wheel mixtures with irons which do not naturally chill.

Electric Furnace Installed

The Simonds Mfg. Co., Fitchburg, Mass., has signed contracts with the United States Steel Corporation for license and with the American Bridge Co. for the installation of a five to six gross ton Heroult three-phase electric melting furnace.

It may be a matter of interest to know that the Simonds Mfg. Co. procured the first Girod license in the United States and a small 500 kilogram furnace was installed at its Chicago works for experimental purposes. When the steel mill of the Simonds Mfg. Co. was moved from Chicago to Lockport, N. Y., in 1910, this furnace was moved as part of the regular equipment. In 1914 this small furnace was dismantled and a larger one was designed and built by the engineers of the Simonds Mfg. Co., following very closely the original Siemens type, with one electrode in the hearth and one electrode through the roof. The results obtained from these two furnaces, covering a period of nearly five years have indicated that a larger furnace of the type now building would be desirable.

The furnace and its auxiliaries were designed by the Societe Electro-Metallurgique Francaise and the United States Steel Corporation. Construction work on the buildings, auxiliary equipment, and the furnace itself is well underway and it is hoped to have the furnace under power by January 1.

The plant of the Cleveland Blow Pipe & Mfg. Co., Cleveland, manufacturer of dust collecting and ventilating systems, safety sheet metal guards, etc., has been removed from West Third street to larger and more commodious quarters at 6302 Kinsman road. The new plant affords double the space of the former works and the output will be correspondingly increased.

In 1914 Alaska produced gold to the value of $15,764,259, an increase of about $140,000 over that of the previous year. The copper production totaled 21,450,928 pounds, against 21,659,958 pounds in 1913. The value of Alaska's total mineral production for 1914 was $19,118,080, and that of 1913 $19,476,356. It is estimated that up to the close of 1914 Alaska has produced minerals to a total value of $268,150,000.

The Proper Use of Cores in Modern Molding

How They Reduce the Cost of Making Castings, With a Discussion of Various Kinds of Binders as Well as Green and Dry Sand Cores

By R A Bull

THE word *core* literally means the central or innermost part of a thing. Naturally enough the term when originally applied to molding was intended to designate the part of the mold which was to form that portion of the casting intended to be hollow, but this word as used in the foundry has come to mean much more than that, and today is a misnomer. A core in the accepted, modern, technical sense is any auxiliary part of a mold which is made separately from the main part and which performs the function of helping to shape the casting. As foundrymen we must interpret the word in the way common to the industry. As etymologists we would probably create a more satisfactory term.

A discussion of the part the core has played in the development of the art of molding necessarily must be condensed or become a detailed account of improvement in molding methods extending through generations long since departed. Such a resume might be of historical interest, but is not contemplated in this article. We are chiefly concerned with the functions and manufacture of cores as they have latterly reduced our molding costs and as they promise further economies.

A Basic Principle

We may not realize, on casual thought, that the principle embodied in the use of the stop-off core with its almost inexhaustible modifications is the basis for much of the development in the art of molding. The stop-off core could be dispensed with and yet the casting might be molded. The operation is tremendously simplified by its use. Therein lies the interesting feature of the use of cores and the one that has given birth to manifold applications, many of which are of comparatively recent origin.

Given a reasonable number of castings to make from one design, we should bear in mind that in all likelihood the two largest items of expense to us will be the labor of molding and finishing the castings (using the term finishing in its broad sense and not simply as indicative of machining). If a casting is to be floor-molded, unless it is of very plain or peculiarly intricate design, the mold can be made in several ways, one of which may require the use of a three-part flask, another a two-part flask and another a one-part flask. Green sand molding is generally considered as the cheapest means for making the ordinary casting, and yet we find it sometimes to be the most expensive. We must be governed as to the construction of a pattern, not simply by the facility with which the facing may be rammed, but also by the ease with which the pattern may be drawn, by the tendency of all parts of the mold to *stay put* during these and subsequent operations, and by the speed with which these operations may follow each other. In such analysis, it should be kept in mind that the total cost of ramming, baking and handling a few cores is but a fraction of that required to tediously manipulate lifting plates or cheeks in the majority of cases.

How Cores Reduced Molding Cost

The writer recalls a casting formed of several horizontal and transverse I-beam members, the total area covered by the flask being considerable. The original method employed in making the mold was by means of a three-part flask, almost the entire mold being made of green sand. It required the skill of five molders and three helpers for two days to make one such mold, and the casting showed the unsightly effects of the impossibility of keeping the cavities in the mold free from dislodged sand. It was apparent that this method of making the casting was very expensive, and lifting plates necessitating the use of several hundred pounds of heavy steel rods were cast and for a time employed, thus eliminating cheeks. This enabled six molders and four helpers to make a mold in one day. After some time the idea of forming the metal between the top and bottom flanges with dry cores instead of green sand was suggested, and when it materialized, four molders and two helpers were able to make a mold in one day. This method of course necessitated considerably greater cost, and the expense of making one complete set of cores was four times that occasioned by each of the two former methods, but nevertheless representing only one-half of a day's pay for a molder. The top flanges of these particular castings were comparatively narrow and the upper surface of the pattern was almost straight. These conditions lent themselves admirably to the use of covering cores, for which suitable binders were designed, superseding the large and unwieldy copes. The application of covering cores enabled one molder and one helper to make a mold in one day, and raised the core cost to 65 per cent of a molder's wages. A simple calculation showed that the total cost of molding and coremaking for these castings was gradually reduced in the proportion of 6 to 1 and that the use of cores in this development reduced this cost in the ratio of about 4 to 1. Other distinct advantages were secured. The appearance of the castings improved to a marked degree. The finishing cost was correspondingly reduced by 30 per cent, and the overweight of the castings dropped from 10 to 4 per cent. Just half the floor space for molding was required after the covering cores and binders had superseded the cope. Gagger expense was eliminated, and was not to any appreciable extent offset by the use of core rods. This is simply a typical example of the way in which cores may be employed to advantage in a manner entirely apart from the function for which they were originally intended.

Opportunities for Extensive Use of Cores

To make many such castings in this way necessitates suitable core room facilities and systematic means for handling cores. In forming the comparisons we should bear in mind that the direct labor of making all cores either by day work or by piece work is in most cases probably not more than one-half the total core room expense, and that in many foundries the indirect labor in the core room is a greater percentage of the whole than the indirect labor on the molding floor. Despite all such allowances, if the general design of the castings lends itself reasonably well to any such development as has been above cited, great economies are sure to result by advancing the core room to a more important position in foundry operations. The degree to which coring may be largely employed in molding shops must, of course, be governed by the nature of the castings, and this paper might be elaborated by citing many examples

A paper presented at the twentieth annual meeting of the American Foundrymen's Association, Atlantic City, Sept. 28-Oct. 1. The author, R. A. Bull, is manager of production, Commonwealth Steel Co., Granite City, Ill.

without accomplishing any useful purpose. The subject itself is a tremendously important one, but its limitations for profitably extended treatment in a paper are readily apparent. Each foundry must work out its own salvation as prescribed by the designs of its castings, and the amount of duplicate work. Be it remembered, however, that "copeless wonders," as they are occasionally called by molders, while adapted more readily to patterns having narrow straight top surfaces, may be economical substitutes for the customary cope and drag if angles and radii to some extent break up the plane of the mold's upper surface.

Handling and Storage of Cores

A few desirable considerations that should be given to the manufacture and use of cores which can be profitably carried on in an extensive way, may be appropriately presented for discussion. Any system which does not primarily provide for the handling of cores in sets will be found unsatisfactory, save in those cases where molds require very few cores, and where these are of standard design. The confusion resulting from ignorance of the number of complete sets of cores on hand is considerable. This factor necessitates liberal facilities for storage and handling. And since it is decidedly advantageous to handle all cores the least possible number of times, much thought should be given to the expedition with which a core may find its way from the oven to the molder. There are plants where operations are so extensive that cores require handling for considerable distances through several channels. The amount of binders in such cases must be considerably greater than that simply required for withstanding pressures exerted in the mold, and should take into consideration the expense of breakage in handling and the importance of maintaining well-defined edges on the cores. Skill in drying is a very important adjunct in maintaining ideal conditions in these respects, and is indicated not only by the time required for baking, but by the character and control of the fuel and by the condition of the ovens. It can be appropriately remarked in passing that mechanical stokers adapt the use of coal to splendid advantage for core ovens, which give the best results under pyrometer control.

Any study of sand binders is most interesting and profitable. There is much deception practiced upon foundrymen by purveyors of foundry flours and other binders. Large foundries have conveniently at hand means for safeguarding themselves in such purchases which the smaller shops do not enjoy. Nevertheless, the latter can advantageously use a few simple tests to determine certain essentials. By placing a flame similar to that produced by a Bunsen burner under a refractory vessel containing a sample of wheat flour, the absence after combustion of any residue save a sort of yellowish film on the vessel will quickly convince anyone who has no knowledge of chemistry that there is no plaster of paris or limestone present. An effervescence produced by pouring a small amount of vinegar on a flour sample is evidence that pulverized lime rock or a similar material has been used to defraud the foundryman. Scrutiny as to the arts of the conscienceless salesman is necessary, since it can be stated that materials containing 50 per cent of substances which never saw a wheat field, and which were added solely to swell the mass, have been offered to foundrymen as superior foundry flours.

The presence of sea coal in dry core compound can only be guessed at in the small foundry. Where facilities in the shop are available for making homogeneous sand mixtures, there is no reason for purchasing dry core compound containing any percentage of sea coal, when it is remembered that this commodity can be bought readily at one-fourth to one-fifth the cost of a prepared compound, and that it frequently represents 15 per cent of the mass in the latter. The economy of purchasing separately any amount of sea coal found advisable to use in mixtures is obvious, given proper mixing facilities.

Wheat flour is a commodity, the price of which has been greatly increased by the European war. It is now one of the most expensive ingredients we may use in our core sand. Rice flour is a substitute which can be secured under present conditions at a much lower price with the best results. Its bonding strength on the sand fully equals that of wheat flour. The use of either rice or wheat flour can be materially reduced in many cases without any bad effects by using cheaper binders to make the core hold its shape in a green condition.

Essential Functions of Binders

There seems to be no reason for the use of several kinds of binders except as those are required for the two essential functions of keeping the core stiff enough in its green condition to enable handling to the oven and making it desirably hard after being baked, always providing that undesired properties, such as affinity for moisture and tendency to volatilize are not present in excessive degree. The strength of pitch, which is the basis of nearly all dry compounds, comes into play after baking, and this necessitates the use of another binder as an adjunct. If suitable bonding materials are purchased separately and mixed with the sand thoroughly, pulverized pitch alone can be satisfactorily employed in lieu of dry compounds bearing a trade name. The writer has no quarrel with manufacturers of core compounds, but feels that the cloak of secrecy which is sometimes thrown about these materials can be removed with profit to the foundryman and to the honest dealer in foundry supplies.

Degree of Fineness of Sand Binders

The degree of fineness to which clay, pitch and other binders are pulverized is very important in predetermining the bonding effect of sand mixtures. Any tendency to coarseness, which may be readily ascertained by the use of a few inexpensive screens, is objectionable. The bonding strength of core sand treated with a pitch compound, of which 75 per cent passed a screen of 200 meshes per square inch, has been found to exceed by 15 per cent or more that attained by mixing with the sand the same volume of an identical compound of which only 35 per cent passed the same screen. The fineness is important from another standpoint. The finer the material the less it weighs per cubic foot within the ranges common to dry binders. The foundryman buys such commodities by weight and generally uses them by bulk measure. While he accordingly uses less binders per unit of bulk measure in his sand mixtures as the degree of fineness increases, the strength of his cores is not reduced, but is indeed actually increased by reason of the better distribution in the mass attained by the finely pulverized bonding agents.

There are several liquid binders on the market which are treated by-products of paper mills, and which are preferable to molasses as liquid binders. These are supplied with a desired degree of uniformity impossible to secure in the purchase of molasses from different jobbers. Considering that these binders obtained in the manufacture of wood pulp when mixed with foundry sand will yield fully one and one-half times the strength of molasses sand, it will be admitted that they have an important function to perform in the core room, especially since they may be purchased at prices which compare favorably with that of molasses.

A simple briquette testing machine is an admirable means for determining relative bonding strength. The cost of such a machine could be borne by any foundry. The art of using it can be acquired readily by any amateur. A word of caution might be mentioned as to the necessity for identical treatment of briquettes to be comparatively tested.

Bearing in mind that the cost of cores is considerably increased by the baking process, we may profitably employ green sand cores in many instances. As these

(*Continued on page 474.*)

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Trade Outlook

EVERY branch of the foundry industry reports a greatly increased melt, and the large number of new projects for casting manufacture that are being undertaken and the many additions that are being made to existing plants indicate unusual activity throughout the entire trade. While it is admitted that foundrymen are the indirect beneficiaries of the large amount of war business that has been and is being placed, nevertheless the home market shows distinct improvement, particularly in the east and central west. West of the Mississippi river the return of prosperity is just beginning to be felt and the shops dependent upon the agricultural implement trade are still operating considerably below capacity. The heavy buying of cars by the railroads will result in the placing of a large amount of work with the steel foundries and the malleable shops. Foundries specializing in automobile work are crowded to capacity and there is every indication that this heavy demand for motor car castings will continue throughout the winter. Raw materials continue to advance and heavy buying is reported into next year. A shortage of pig iron is predicted, although many furnaces are still idle and will come into blast when prices will enable them to operate at a profit. Pig iron production is at the high level in the history of this industry and it is believed that a new record was made in October. In the leading centers, foundry iron is quoted as follows: No. 2, Chicago, $15.50; Buffalo, $15.50 to $16; Philadelphia, $16.25 to $16.75; Virginia, $13.75 to $14; Birmingham, $12.50 to $13, and Pittsburgh, $15.90. Malleable iron is quoted at $15.50 and Lake Superior charcoal at $16.25 to $17.25, Chicago.

An Experimental Foundry

ONE OF the most interesting recommendations made at the annual meeting of the American Foundrymen's Association was contained in a paper presented by H. K. Hathaway, entitled "Scientific Management and Its Relation to the Foundry Industry". The author, in concluding his exceedingly valuable contribution to existing literature on this subject, suggested the establishment of an experimental foundry by the Association, in which research work connected with making time studies of molding could be carried on. This co-operative effort would distribute the burden among a large number of foundrymen, all of whom would benefit from the working-out of this problem as applied to the foundry industry, and the burden of cost would be small for each casting manufacturer, as compared with individual investigations and their attendant duplication of efforts. It is pointed out that such a foundry also might be used as a training school, not only for molders, but for foremen and superintendents. The expense to be borne by the members might be reduced by placing the foundry or laboratory on a productive basis, and while it should not be expected to earn a profit, its income might at least bear a larger part of the cost. Unfortunately, the American Foundrymen's Association is without means for undertaking experimental work of this kind, which would involve a large initial outlay, and the only method by which it might be undertaken would be through the solicitation of subscriptions for this special fund. No action on these recommendations was taken at Atlantic City, although they are worthy of serious thought on the

part of all casting manufacturers. In considering the establishment of such a foundry, existing laboratories or schools designed to train molders, foremen and superintendents should not be overlooked. In recent years many trade schools have added courses in foundry training, and if these do not meet with the necessary requirements, it is largely the fault of the foundrymen and not the educators, since American manufacturers, to a large extent, have assumed an attitude of criticism rather than of helpfulness so far as the conduct of these schools is concerned. Before undertaking the raising of funds for an experimental foundry as recommended by Mr. Hathaway, it might be advisable to ascertain whether any of the existing schools would undertake working out the problem of scientific management as applied to foundry work. In favor of the foundry under the jurisdiction of the American Foundrymen's Association, it has been argued that the experiments would be made under the direct supervision of practical men, who would be headed for one goal, and the scattering of efforts would be obviated entirely. Furthermore, in the training of foremen and molders, the instruction would not be similar to, but the same as might be had in any commercial shop. The undertaking, if carried on as outlined, would mark a distinct departure in training men for positions of responsibility in the industrial world, as the work entirely would be under the control of the manufacturers in place of the educators. That scientific, or efficiency management, as some prefer to term it, will be applied to foundry work generally in the near future, is not denied. The best and most economical method of solving the problem is the only question under consideration. Those who are inclined to picture the efficiency engineer as a disturber with a split second stop watch in one hand, must not overlook the fact that time studies are only one feature of this science, which is all-inclusive and takes in every phase of management. That foundry operations generally can be greatly improved and that much money can be saved through proper management, will be admitted, and if Mr. Hathaway's recommendations serve no other purpose, they have called attention to another phase of foundry work which the casting manufacturer too frequently overlooks in his anxiety over mixtures, labor problems, etc.

Application of Uniform Costs

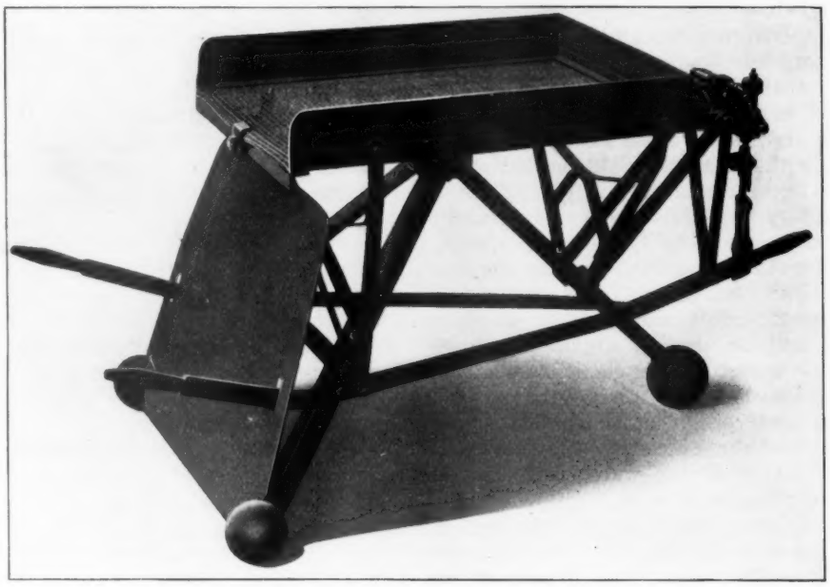
FOR a number of years the efforts of the American Foundrymen's Association have been directed toward the adoption of a uniform cost system in the casting plants of this country. The ideal to be achieved, of course, is apparent. With costs figured on the same basis, cut-throat competition could be eliminated and the foundryman could be assured a profit on every job, provided shop losses, of course, would be held within reasonable bounds. It is appreciated, however, that differences in quotations would still maintain, regardless of the universal adoption of a uniform cost system, as the overhead varies in all plants and some are better equipped for economical manufacture than others. These conditions would have a tendency to scale down the profits of the poorly equipped plants if they desired to compete on the same basis and would prove an incentive to them to improve their practice and to install labor-saving machinery. The foundry industry is not unlike many other branches of trade in which the crying need is for adequate cost systems rather than for artificial price control. When a manufacturer knows his costs, prices usually will take care of themselves. It is the manufacturer who does not know what his costs are, who is the source of ruinous competition and it is for his training and education that the American Foundrymen's Association has undertaken the establishment of a uniform basis of figuring costs. It is doubtful if any foundryman is operating without a cost system of some kind, but the question is whether the system is truthful and whether it gives him his *actual* costs. The system recommended for adoption by this organization represents the best thought of practical foundrymen who constituted the cost committee and its principles can be applied in any foundry, iron, steel or brass, jobbing or specialty. Heretofore the cost committee merely has recommended the adoption of its system, but this year a specified plan has been outlined by which it believed a beginning will be made in the installation of a uniform cost system in the foundries of the United States. The employment of an expert has been suggested who will devote his efforts to the installation of this system in the foundries of the members of this Association. Every foundryman to be favored with the services of this expert is to contribute $50 toward a common fund to carry on this work. It is believed that if 100 contributions can be received, the fund will be sufficient to carry on this work for at least a year. An effort will be made, in the very near future, to obtain subscriptions for this fund and it has been suggested that foundrymen not desiring to subscribe for themselves might do so for the good of the cause, to help others whose quotations indicate that costs are not considered in estimating prices. The plan merits the hearty support of all foundrymen who are interested in the establishment of better trade practices and it is certain that ruinous competition never will be eliminated until all casting manufacturers know their costs. The report of the committee will bear careful reading by all interested in cost-finding. The distinction made between fast and slow-moving jobs is particularly interesting and here undoubtedly is the stumbling block that leads many foundrymen astray.

Coke Production in 1914

IN 1914 the production of coke in the United States was the smallest since 1908 and amounted to 34,555,914 short tons, valued at $88,334,217. Compared with 1913, when the production was 46,299,530 short tons, valued at $128,922,273, the output in 1914 decreased 11,743,616 short tons, or 25.4 per cent in quantity and $40,588,056, or 31.5 per cent in value. Of the total production in 1914, 23,335,971 tons were beehive coke and 11,219,943 tons by-product coke, as compared with 1913, when the beehive production was 33,584,830 tons and the by-product output 12,714,700 tons. It is interesting to note that in 1914 the decrease in the production of by-product coke was only 12.7 per cent, whereas the decrease in beehive coke was 87.3 per cent. With the exception of two years, 1908 and 1914, the production of by-product coke has increased each year since the first ovens were completed in Syracuse in 1893. Except in 1909, the percentage of by-product coke to the total also has increased each year. In 1901 it was 5.4, in 1910 it was 17.1, in 1912 25.3, 1913 27.5 and in 1914 32.5. The average value per ton of beehive coke in 1914 was $2.15, against $2.39 in 1913, whereas the average for retort coke was $3.39 in 1914 as against $3.82 in 1913.

Large Tripod Pneumatic Sifting Machine

The Hanna Engineering Works, of the Vulcan Engineering Sales Co., Chicago, builds pneumatic sifting machines in a variety of sizes and in the accompanying illustration is shown a machine with a screen box, 2 feet wide and 3 feet long. The machine is constructed entirely of steel and is so designed that screens of any desired mesh can be employed. When removing a screen it is only necessary to detach the nut at the end of the piston rod. The screen box is slightly inclined and the lower end is left open so that large particles which will not pass through the screen freely may be automatically and continuously discharged over the sheet iron apron at the end which keeps the screened sand separated from the rejections. The uprights for the screen box are so arranged that the incline of the screen may be adjusted to different angles, and, therefore, control the speed at which the coarse material is discharged. This machine is supplied with the suction oiler and ejection throttle valve described in the August, 1915, number of *The Foundry*. In malleable iron foundries this machine is employed to advantage for screening packing material, the large pieces which are used for packing the castings being discharged freely over the end of the screen while the fine material is sifted through the wire mesh.



HANNA TRIPOD PNEUMATIC SIFTING MACHINE

Proper Use of Cores in Modern Molding

(*Continued from page* 471.)

comprise a relatively small percentage of all cores made in the average foundry, and as they present few complications or opportunities for novelties in manufacture, it is not thought best to discuss them at length in this paper. Very ingenious arbors have been devised for supporting the sand in green cores, and for subsequent removal from almost inaccessible parts of castings. Extremely useful applications of green cores have been made to overcome shrinkage difficulties, where the expedients of introducing quickly combustible or easily compressible materials in the interiors of dry cores do not yield the best results. The importance of green cores should not be minimized, but very detailed discussion of them necessarily has more of a local interest than a general one.

A factor which has militated considerably against the more economical use of cores in jobbing shops is the practice that many consumers of castings unfortunately adopt, of providing their own patterns. Users of castings frequently make themselves, or have made, all pattern equipment at the lowest possible cost, irrespective of the number of castings required and the application of simplified molding methods. We may admit that this is a condition difficult for us, as foundrymen, to adjust. I, however, believe that we could, with much advantage to ourselves and to consumers, emphasize this factor more vigorously than we have in the past. It is sometimes quite effective to make alternative quotations on castings to be made from patterns furnished by the foundry.

The electric furnace installed at the plant of S. Fair & Sons, Inc., Saginaw, Mich., by the Snyder Electric Furnace Co., Chicago, is in operation and has been accepted from the builders. The furnace was installed under a guarantee that the kilowatt-hour consumption per ton would not exceed 880 during the first two heats. The consumption per ton averaged 620 kilowatt-hours and the third heat from a hot furnace, 580 kilowatt-hours. Basing the current on 1 cent per kilowatt-hour, the cost of operation was $3 per ton less than that guaranteed by the Snyder Electric Furnace Co.

High Silicon Castings

By Richard Moldenke

Question:—We are anxious to produce a heat containing 10 or 12 per cent silicon and we would like to know how to proceed. We operate an air furnace, but presume that this metal should be melted in the cupola. We believe that charging 50 per cent ferro-silicon in the cupola would result in quite a loss of silicon and we would like to know whether so high a percentage of this alloy can satisfactorily be added in the ladle.

Answer:—Since you have an air furnace you have the best means of solving the problem. First melt ordinary stock, and when a good heat has been attained, add the required ferro-silicon, aiming at the 12 per cent limit. Unavoidable oxidation will bring the charge a little below that point. Be sure to rabble the bath well before tapping to insure uniformity in composition. Melting ferro-silicon in the cupola is not to be recommended, but if the cupola must be used, the safest way is to keep the bed high enough to bring the first iron at the spout in 12 to 15 minutes instead of the regular 8 to 10, in order to avoid as much oxidation as possible. Be certain that the ferro-silicon is in large lumps, so that small pieces may not roll down into the bed and lodge in front of the tuyeres. Otherwise there is danger, not only of heavy oxidation, but also of carrying molten globules of ferro-silicon into the castings. Adding enough ferro-silicon in the ladle to bring ordinary mixtures of iron up to 10 or 12 per cent silicon would unredeemably cool the metal.

The Cloverport Boat & Mfg. Co., Cloverport, Ky., J. W. Pate, manager, will erect a 30 x 140-foot building with two wings, each 30 x 30 feet, and will conduct a foundry and machine shop.

Driver-Harris Wire Co., Harrison, N. J., has let the contract for a brass foundry.

Vitaphone Co., Plainfield, N. J., will begin work shortly at Netherwood, on a brass foundry.

Two-Piece Jolt Rammers

The Mumford Molding Machine Co., Chicago, is now building an 8-inch cylinder jolt-ramming machine of two-piece construction which is designed particularly for heavy duty steel foundry work. The machine has a table 30 x 42 inches and a capacity of 2,500 pounds at 80 pounds air pressure. For draw bars and knuckles it is used in combination with the Mumford pit pattern draft machine.

To Chill Gray Iron

By W. J. Keep

Question:—We make a great many castings for shelling corn which have teeth 1 inch square and about 1 inch long. These are cast in a chill. Occasionally we do not have enough of these castings to make a special mixture, and must pour them from our regular metal. When we do, they are too soft and the teeth are not chilled sufficiently deep. What alloy would you recommend adding in the ladle to make the teeth harder? Some of the castings must be bored out in the center for a shaft and cannot be too hard at that point, especially the teeth. Also kindly give me the analysis of a good iron for chilling purposes. We charge some sheet steel scrap boxed in 100-pound charges.

Answer:—If you will add steel punchings to the metal in the ladle, you will find that the iron will give quite a chill. Care should be exercised, however, not to add any more steel punchings than the iron will melt. A small piece of sulphur, about the size of a chestnut, placed in the ladle before catching the iron, also will cause the iron to chill and it will increase the hardness. In either case, however, the amount to be used should be determined by experiment. For a chilling mixture, keep the silicon as low as possible and considerable scrap also might be used, as the sulphur should be high.

Personal

J. H. Taylor has resigned as superintendent of the pattern department of the Treadwell Engineering Co., Easton, Pa., to accept a similar position with the Fore River Ship Building Corporation, Quincy, Mass.

Dudley Shoemaker, vice president and general manager of the Atlantic Steel Castings Co., is preparing for operation the plant of the Keystone Steel Castings Co., Chester, Pa., which has been purchased by the Atlantic Steel Castings Co. Mr. Shoemaker was formerly works manager of the Indiana Harbor, Ind., plant of the American Steel Foundries.

Since 1911, the world's platinum production has steadily declined from 314,328 troy ounces to 263,453 troy ounces in 1914. On the other hand, the selling price of platinum has steadily increased since 1909, when it sold as low as $23 an ounce, whereas the average selling price in 1914 was $45 an ounce.

White Cores in Castings

By W. J. Keep

Question:—While cleaning castings at a foundry recently, one was broken and it seems to have been chilled in the center while the chilled core was surrounded with gray soft iron. Do you think it possible that two grades of iron were in the ladle and that each grade segregated?

Answer:—In chapter XII of my book entitled "Cast Iron," an illustration is given of a casting ⅛-inch thick which contained seven alternate layers of white and gray iron. At the time this book was written I was unfamiliar with the conditions that produced this phenomenon. Later I learned that with some mixtures, if the first iron that comes down onto the cupola bottom is caught in a green ladle and if this iron is poured into another green ladle, the casting will be gray on the outside and white in the center. However, this is not always the case. It is well-known that molders are liable to take into a green ladle the metal left in ladles by other molders and to avoid trouble such iron should be poured in the molds, the castings from which do not have to be drilled. If all castings are to be machined, the left-over metal from the first dip should be poured into the pig bed. The iron is all of one quality in any ladle and it is difficult to explain this peculiarity. The chemical composition of the white and the gray iron is the same with the exception of the carbon, although the total of the two is the same in each.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Vermont Snath Co., Springfield, Vt., is now located in its new foundry.

The Talladega Foundry & Machine Co., Talladega, Ala., contemplates extending the capacity of its plant.

The American Bell & Foundry Co., Northville, Mich. has increased its capital stock from $32,000 to $50,000.

The Southwark Foundry & Machine Co., Philadelphia, has increased its capital stock from $500,000 to $1,300,000.

The Industrial Foundry Co., St. Johns, Mich., has purchased the plant and equipment of the St. Johns Foundry Co.

The G. E. Hoglund Foundry Co., Gardner, Mass., has been incorporated with $10,000 capital by G. E., A. and L. Hoglund.

The foundry and machine shop of William Garrett & Sons, Tweed, Ont., Can., has been taken over by S. G. Way, Belleville, Ont.

The New England Radiator Co., Boston has been incorporated with a $25,000 capital to engage in the manufacture of hot air radiators. The directors follow: William W. Phillips, president and treasurer, C. G. and M. I. Kellogg.

The Mascot Stove & Mfg. Co., Dalton, Ga., has leased and will operate the plant of the Mountain City Stove & Mfg. Co., Chattanooga, Tenn.

The Little Rock College, Little Rock, Ark., will equip a foundry, machine shop, engineering building, etc., and is in the market for machinery.

The La Foundries de Victoriaville, Ltd., Victoriaville, Que., Can., has been incorporated with $49,000 capital to engage in the foundry business.

The Gyro Metal Works, Norfolk, Va., will install a gray iron foundry department in December. Brass and aluminum castings are now being made.

The Sorel Steel Foundries Co., Ltd., Sorel, Que., Can., has been incorporated with a capital stock of $100,000 to take over the business of Beauchemin & Fils, Ltd., at Sorel. The incorporators are Louis P. Tremblay, Napoleon Latraverse and others.

The Franklin Foundry Co., Franklin, Pa., has been incorporated with a capital stock of $25,000 by John H. Morrison, Cora A. Kahle and U. C. Kennedy.

The Logansport Castings Co., Logansport, Ind., has been incorporated with $150,000 capital, by G. W. Bowen, S. R. Chenoweth and J. F. Digan.

The Castings Co. of Canada, Ltd., Montreal, Que., Can., has been incorporated with $49,000 by Harry Cohen, Alexander Ellison and Stanley G. Metcalfe.

The Tulsa Engine & Foundry Co., Tulsa, Okla., has been incorporated with a capital stock of $50,000 to manufacture engines, hay balers, ventilating machinery, etc.

The Engineering & Foundry Co., Stockton, Cal., has placed its new plant in operation.

The foundry consists of two buildings, 90 x 120 feet and 70 x 100 feet, respectively. The company is capitalized at $100,000 and will manufacture brass, bronze and aluminum castings.

The Acme Die Casting Corp., Thirty-fifth street and Third avenue, Brooklyn, N. Y., has increased its capital stock from $125,000 to $200,000 and will double the capacity of its plant.

The Federal Radiator Co., New Castle, Pa., which recently took over the plant of the Penn Motor Co., is erecting several auxiliary buildings which considerably increase its capacity.

The Atlantic Steel Casting Co., Philadelphia, has been incorporated with $5,000 capital by Clarence Tolan Jr., Wayne, Pa., Thomas E. Rodman, Llanerch, Pa., and James B. Dunker, Philadelphia.

The Railway Supply & Equipment Co., Pittsburgh, has been incorporated to engage in a general foundry and machine business. The incorporators are Kate G. Small, A. D. Starrett and W. A. McCoy.

New Construction

John Rohrberg, Camas, Wash., is building a brass foundry.

The Weir Stove Co., Taunton, Mass., is erecting an iron foundry.

The Atlantic Foundry Co., Akron, O., will build a foundry, 100 x 76 feet.

The Missouri Iron Co., St. Louis, Mo., will build a foundry at Ashtabula, O.

The California Iron Works, Riverside, Cal., will erect a foundry and machine shop.

The Anderson Foundry & Machine Co., Anderson, Ind., will build two additions.

Samuel Butters, 421 Old Colony avenue, Dorchester, Mass., will erect a foundry.

The Maryland Steel So., Sparrows Point, Md., will build a foundry, 100 x 625 feet.

The Keystone Casting Co., Chester, Pa., will build an addition at a cost of $30,000.

The Jewell Steel & Malleable Co., Buffalo, N. Y., will erect a core room, 64 x 80 feet.

The Bay View Foundry Co., Sandusky, O., will build a one-story addition, 60 x 125 feet.

The Whitin Machine Co., Whitinsville, Mass., is building a 50 x 150-foot addition to its foundry.

The Atlas Foundry Co., Cleveland, will erect an addition to its plant at a cost of $1,000.

The Milwaukee Die Casting Co., Milwaukee, will build a $12,000 foundry and manufacturing building.

The Elmwood Castings Co., Cincinnati, O., will build a one-story, 60 x 80-foot addition to its plant.

The Queen City Foundry Co., Cincinnati, O., will erect a one-story addition, 12 x 30 feet.

The French Creek Foundry Co., Franklin, Pa., will rebuild its shop recently damaged by fire.

The Atlas Brass Foundry Co., Columbus, O., will erect a three-story machine shop, 28 x 40 feet.

The Wehr Steel Co., Milwaukee, Wis., is building a one story brick and steel foundry addition.

The Russell Wheel & Foundry Co., Detroit, is building an addition to its plant at a cost of $15,000.

The Roan Foundry Co., Lebanon, Pa., will enlarge its cupola capacity and storage department.

Work has begun on the erection of a foundry, 85 x 69 feet, for the Smith & Winchester Co., Windham, Conn.

Bids are being received for the erection of an addition to the foundry and other buildings of the Seattle-Astoria Iron Works, Seattle, Wash.

The contract has been awarded for an addition to the foundry of the Atlas Steel Casting Co., Buffalo, N. Y.

The Alma Standard Foundry Co. will build a foundry at Saginaw, Mich., and will move from Alma, Mich., to Saginaw.

The Manistee Iron Works, Manistee, Mich., will build a cupola room, 30 x 32 feet, and a core room, 20 x 30 feet.

The Western Gas Construction Co., Fort Wayne, Ind., contemplates rebuilding its foundry recently damaged by fire.

The Rhode Island Malleable Iron Works, Providence, R. I., will erect a one-story, brick and frame addition to its core shop.

The contract has been awarded for the erection of three buildings for the Springfield Foundry Co., Springfield, Mass.

The Roeller Foundry Co., Bay City, Mich., is tripling its capacity by an addition to its plant. Machinery is being installed.

Joseph Schermuly, Ellinwood, Kan., manufacturer of sleds and cultivators, will build a foundry, 50 x 80 feet, at Wichita, Kan.

The Canton Steel Foundry, Canton, O., is completing additions to its plant costing $25,000 and will install additional equipment.

The Modern Foundry Co., Oakley, Cincinnati, O., will erect two additions, one 74 x 82 feet and the other 30 x 210 feet.

The American Scale Co., Pleasant Hill, Mo., is building a branch at Kansas City, Mo., for which foundry equipment is needed.

The Kokomo Brass Works, Kokomo, Ind., founders and machinists, will build two additions, one 211 x 55 feet and the other 66 x 312 feet.

The Dominion Brake Shoe & Foundry Co., Ltd., St. Thomas, Ont., Can., has been incorporated with $200,000 capital to engage in the manufacture of brake shoes, iron and steel castings, forgings, etc. A foundry will be erected at St. Thomas.

The Magee Range & Furnace Co., Taunton, Mass., is building a foundry which will have a melting capacity of 70,000 pounds of iron daily.

The American Range & Foundry Co., 7000 Union avenue, Cleveland, contemplates erecting a 52 x 92-foot, brick addition to its foundry to cost approximately $6,500.

The Plattner-Yale Mfg. Co., Denver, Colo., manufacturer of implements, will build a foundry, 50 x 150 feet, and a machine shop, 52 x 200 feet, at Lincoln, Neb.

The Nichols & Shepard Co., Battle Creek, Mich., is erecting an addition to its shipping room and is remodeling its foundry. Additional foundry equipment will be installed.

The contract has been awarded for a foundry addition, 50 x 51 feet, to be erected for the P. & F. Corbin Division of the American Hardware Corp., New Britain, Conn.

Bradley & Ankebrant Co., Muskegon, Mich., manufacturer of cast iron plumbing goods, contemplates the erection of a foundry, 60 x 100 feet; a machine shop, 40 x 60 feet, and several smaller buildings.

Plans have been prepared for a reinforced concrete steel and brick foundry, 120 x 240 feet, to be erected at Spring Grove avenue and Arlington street, Cincinnati, for the John A. Oberhelmann Foundry Co.

The Northern Brass Co., Whitinsville, Mass., has been incorporated with a capital stock of $15,000. A foundry will be erected which will give employment to 25 men. Setrak K. Boyajian, Worcester, is president.

The Eugene Iron Works, Eugene, Ore., manufacturer of transmission machinery, contemplates the enlargement of its plant and will erect new buildings consisting of a foundry, machine, pattern, blacksmith, boiler and stove shops.

NEW TRADE PUBLICATIONS

FOUNDRY SUPPLIES. — In a '48-page catalog issued by the Gem Mfg. Co., Pittsburgh, its extensive line of supplies for foundries and other industrial plants are illustrated and described. These consist of oilers and torches, foundry chaplets, flue scrapers, flexible shafting, special dies, metal stampings and specialties. Several views are included showing this company's extensive manufacturing facilities.

PNEUMATIC TOOLS AND EQUIPMENT. —The Ingersoll-Rand Co., 11 Broadway, New York, has issued a series of bulletins describing its extensive line of pneumatic tools and equipment. The bulletins are devoted respectively to riveting, chipping, caulking, scaling and flue-beading hammers, which are adaptable to a variety of industrial purposes. One bulletin describes air compressors with short belt drive and another is devoted to the Ingersoll-Rogler compressor and details of its construction are included. The hoist manufactured by the Ingersoll-Rand Co. also is illustrated.

COMBINATION MOLDING MACHINE.—In an eight-page folder, the Tabor Mfg. Co., Philadelphia, illustrates and describes its portable, combination shockless jarring, roll-over and pattern-drawing molding machine. It is provided with an 8-inch straight pattern draft and will handle flasks 18 inches wide, 36 inches long and 12 inches deep, weighing not to exceed 450 pounds, with 80 pounds air pressure. Four views of the machine are included showing the flask filled ready for jar-ramming, rolling over the mold, drawing the pattern ready to roll back and the finished mold with the pattern on the jarring machine table ready to receive another flask.

THERMIT.—An 80-page catalog, issued by the Goldschmidt Thermit Co., New York, discusses the use of thermit in mill and foundry practice. The catalog contains detailed information and directions for welding wrought iron and steel sections and numerous illustrations are included showing various classes of work repaired by the thermit process. Also, the various jobs are described in detail, which makes the catalog exceedingly valuable to those engaged in this work or contemplating thermit welding operations. The use of thermit for increasing the temperature of iron and steel, particularly in the ladle, also is discussed and the making of semi-steel in the ladle is described. A chapter on the use of thermit in foundry practice is exceedingly interesting and should prove of to every foundryman engaged in the facture of iron and steel castings.